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An Illustrated Weekly Journal

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An Illustrated Weekly Journal

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STEEL

REPORTS of steel shortages have multiplied in recent weeks and anxiety is growing among users concerning supplies this winter. As a result, companies are bidding for available supplies, and delivery delays are increasing. The situation is summed up by three salient facts: in the first nine months of the year consumer stocks have risen by some 200,000 tons; merchants' stocks have fallen by 80,000 tons; and at the end of June steelmakers' orders on hand were 70 per cent. higher than a year ago. Some engineering works report disrupted schedules due to supplies of certain steels being late, and a few civil engineering and public works contractors complain of similar difficulties. There is, as yet, no acute shortage but, clearly, there is a definite threat of one.

What the Government intend to do has been said and said again in recent weeks and will be more precisely defined as we go to press: in the main it is to "blow the froth off" demand, to check inflation by reducing purchasing power at home. The Treasury published their views on the steel situation in the October issue of their *Bulletin for Industry*: "In the months ahead it is important that home demand should be limited. For while the country's total exports have been growing, they have not increased fast enough to keep in step with the expansion of the economy. Recent measures should help to restore a balance"; which in practical terms means that the Government expect a combination of high Bank Rate, credit squeeze and a good measure of purchase tax to reduce home demand for steel.

Are such monetary measures the best means to achieve this? "Froth" is a normal accompaniment of rapid growth; the Treasury's measures may well arrest the growth in the endeavour to blow off the froth. Few manufacturers question the need to export more engineering products or would argue that the ratio of one to four in the expansion of engineering exports to the expansion of production is right. Most of them would join issue with the Treasury on the means, not the purpose, and many would question the basic assumption that to reduce home demand will necessarily restore a balance between the increase in output and the increase in exports. It may well increase the disparity. To a large extent the conditions and nature of current industrial growth are new to this country: never previously has scale of output meant such staggering gains in productivity. Like the United States before us, we are gearing our metal-consuming industries (and those on which they depend for their supplies) on the production of goods that are sold to individuals or for the use of individuals. This means a demand for relatively large numbers of standard items, which makes possible the use of automatic machinery and puts us on the way to becoming competitive in this field in world markets. To interfere with the process of growth at this early stage could set back the motor vehicle and metal consumer goods industries at a time when they must improve their competitive position overseas in order to continue their growth. In addition, to have a substantial home market allows a flexibility in export pricing.

It is against this background that the supplies of steel should be examined. In the first eight months of the year the output of cars and commercial vehicles was 19 per cent. above a year ago; that of metal consumer goods rose 20 per cent. in the first six months. Output of plant and machinery on the other hand rose by 4 per cent. only. The motor-vehicle manufacturers expect a rate of expansion in the next four years of over 8 per cent. per annum (which will be greatest this year and next) and consider that the larger output will yield economies which will enable them to export 40 to 50 per cent. of total production. The heaviest demands for steel have therefore fallen on the rolling mills for sheet and light sections, and on the alloy-steel makers for spring steel, certain stampings, etc. The steelmakers are unable to meet this demand and are unlikely even to keep up with it in 1956. The steel industry's expectations are that steel supplies in 1956 will be 12 per cent. higher than this year, when they are expected to be 12 per cent. greater than in 1954. The major uncertainty concerns sheet steel supplies, as European sources are drying up and the United States export surplus cannot be predicted. Alloy-steel supplies, particularly nickel steel, will not grow until alloying elements become more freely available and this is unlikely to be for three years, when supplies of nickel should improve. Consequently substitutes will have to be found and work is going on to this end.

Could the steel industry have foreseen this vast expansion in vehicle and metal consumer goods production when the second Development Plan for Steel—from 1953 to 1958—was drawn up? The answer is probably in the negative, since even the motor manufacturers themselves did not clearly foresee it in 1952. No time should be lost now in expanding capacity, even if the steelmakers have to carry reserve capacity. Only in this manner was American industry able to expand so rapidly as it did in the past decade. The Government may find it more in the nation's interest to exert its influence in this way than to check consumption at home by waving the financial hammer in the hope of hitting the right nails.

Weekly Survey

Cover Picture: *The Pine Portage generating station of the Hydro-electric Power Commission of Ontario, shown in our cover picture under construction, is located 30 miles up the Nipigon River from Lake Superior. The plant, officially opened in 1950, is one of 14 new power sources brought into service by the Commission's expansion programme which was begun at the end of the second World War. Pine Portage generating station to-day has a dependable peak capacity of 153,900 h.p. Together with the output from two other older plants, water from the Nipigon River is now used to produce 299,600 h.p.*

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Productivity of the Mind

It is one thing for an engineer to reflect that he could have had a better education for his profession, but quite another for him to say how it could have been improved. The teacher thinks he knows best: the student cannot know until it is too late. A meeting to be held at the Institution of Mechanical Engineers on November 11 should provoke the clash of opinion which is always latent in this topic.

Mr. P. P. Love, who is technical manager of the Glacier Metal Company, is presenting a paper entitled " A Criticism of the Technical Education of Recently Qualified Engineers." His thesis is that current educational methods only partially train the student in the acquisition of skill in using his mind. He has found that there is a correlation between the effectiveness with which an engineer applies knowledge and the amount of training he has received in fundamental principles. And as fundamental knowledge is itself becoming more extensive, engineers may have difficulty in applying it effectively unless they receive explicit training in the application of knowledge.

Mr. Love will not be proposing a cut-and-dried solution of the problem: he will plead for a scientific approach to it and will suggest a method of carrying out the investigation that is needed. It will be said, no doubt, that the teaching syllabus is already so full that there is no room for yet another subject. But it is precisely because the syllabus is already full, and will overflow in future, that the only possible way out is to spend some time on the fundamentals of how to apply knowledge. It is a fascinating study in itself; and it increases the productivity of the mind. With luck, November 11 will inaugurate a worth-while advance.

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Colleges and Libraries

As recently as last week, librarians and information officers discussed almost the same topic as the Institution of Mechanical Engineers will consider on November 11 (see previous note). Dr. D. J. Urquhart proposed that technical colleges should have well-stocked and well-managed libraries which would serve a double function: be an essential part of the teaching apparatus and act as a public technical library for industry.

From an engineering firm's point of view the economic value of a library is not always obvious. It really needs someone with previous experience of the use of a technical library to sell the idea to the management. Then, if the idea is accepted, the library must be organised to suit the staff and the staff must be educated to use the library. Whether or not this course is adopted, a technical college library serving a number of firms in the locality, as well as the teachers and students, fulfils a very useful function. As there are already several notable libraries of this type in the provinces, perhaps they could produce some information on the running costs and set it against a simple statistical analysis of the use made of the library in a year. Groups of firms in districts not yet served in this way could then present a case to their local authority.

Dr. Urquhart is in favour of the new libraries being allied to the technical colleges rather than to the public libraries. He was giving his personal views, though as an officer of the Department of Scientific and Industrial Research he is in close touch with industry's use of technical information. The argument for the technical college library is strong. Students should be trained in a knowledge of the structure of technical literature. If they learn their way about it at college they will continue to use it when they go into industry. And as he remarked, the latest information is generally to be found in periodicals: text-books usually contain " second-hand " information. He was addressing a joint meeting of Aslib and the Library Association. The coincidence of his subject-matter and the I.Mech.E. meeting on November 11 suggests that the time is ripe for a joint meeting of engineers, librarians and information officers.

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Shipbuilding Boom

Shipbuilders on the Wear have become as optimistic about their prospects as they were pessimistic less than a year ago, and the same can be said to apply to the whole industry. Since January, Wear shipyards have booked 40 contracts worth some £35 million for dry cargo ships, tankers and ore carriers of an aggregate tonnage of half a million tons dead weight. At least an additional 30 contracts are said to have been placed but not publicly announced. A member of the Wear Shipbuilding Association recently said that there is now enough work to maintain peak production for three to four years.

In these conditions British shipbuilders can have little to say if orders are placed in foreign yards by British shipping companies. But even foreign yards are becoming clogged up with orders and cannot offer much better deliveries than our own. The fact is that, at present, demand for ships exceeds, and is likely to exceed in the foreseeable future, the world's capacity to supply them. This applies particularly to modern dry-cargo tonnage and to specialised tonnage, such as refrigerated ships, ore carriers, fruit carriers and others for which this country has a long tradition of excellence. The large tanker orders placed in the past few months were not generally expected and may well delay further the replacement programme of dry-cargo operators who waited too long to step in the queue.

During the summer, Mr. J. W. Elliott, chairman of Swan Hunter, drew attention to " three essential conditions " needed to place British shipbuilders in the strongest competitive position: the re-equipment of yards to enable the adoption of the latest and most efficient methods of ship construction; improvements in organisation and planning of the work; and the collaboration and co-operation of the trade unions. The need to build ships quickly without lowering standards of workmanship is probably the most important of all. If delivery dates are allowed to become too protracted there is always a danger of losing business to those who can build quicker and, particularly, of losing those faithful customers who like to order ship after ship from the same yard.

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Effective Use of Manpower

Under this heading Dr. Alec Rodgers, of Birkbeck College, in his paper to the British Association, drew attention to the work of the occupational psychologist in fitting the man to the job and fitting the job to the man. These two complementary activities are particularly needed to-day in a period of very full employment and of demand for special skills in excess of supply.

Under the first heading Dr. Rodger emphasised the need for careful selection followed by better systems of training. This training may often usefully be given at a later age than has been considered usual in the past, whether it be apprenticeship for a trade or training for management. It may be necessary to turn men with arts backgrounds into production managers. War-time experience in the selection and training of potential engineer officers shows that it is quite possible for a young man who has followed a predominantly arts course to the age of eighteen, or even later, to become competent in a technical occupation. It is for this reason that the Imperial College is to experiment with a preliminary year for students who have not done science at school.

With the coming of " automation " and a fall in the number of young people reaching school-leaving age, fresh thinking will be required on training, especially for the skilled trades. One way of preventing the shortage of skilled manpower from reaching unmanageable proportions is to ensure that the design of equipment takes account of the capacities and inclinations of the average operators. If we do not, is it fanciful to suggest that we may create a situation in which the abler half of the working population have to work themselves silly to earn enough to pay enough taxes to keep the other half sitting around doing nothing?

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Smaller Cotton Industry

One of the engineering industry's oldest markets, namely cotton textiles, is facing up to the possibility of a long-term contraction in its capacity. For some time now, the contraction in the export market and the flow of workers from the cotton mills to other industries in Lancashire have provided evidence of the need for the industry to review seriously its spindle and loom capacity. In the closing stages of the Cotton Board's annual conference last week, Sir Raymond Street, the chairman, said that redundancy in the industry will be receiving the serious consideration of the Board. This had been preceded by an address by the chairman of the Cotton and Rayon Merchants Association in which he had said that the shrinkage in the Lancashire textile trade was permanent and was likely to go on. In these conditions the industry should face up to the need for a voluntary redundancy scheme which would leave the industry more compact and better able to meet foreign competition.

The industry pins its hopes for settling down at a smaller but stable level of capacity on three things. First, it has a lingering expectation of Government assistance in the form of protection of the home market, though Mr. Peter Thorneycroft, President of the Board of Trade, gave no grounds for thinking that the Government's policy on this question would be relaxed in any way. Second, there is some prospect of increased investment by companies in modern machinery which will operate on a multi-shift basis and so reduce overhead costs significantly to give an edge to Lancashire's competitive power. Third, there must be a willingness on the part of employees to accept multi-shift working. There have been some encouraging preliminary discussions among the weaving and spinning unions on a change-over from single to multiple shifts, and it is just possible that management and labour may be able to work out a basis for modernisation which may put back the edge on Lancashire's competition abroad. Textile machinery manufacturers would benefit from further mechanisation of cotton textile spinning and manufacture for they would get not only the business from higher initial orders but also the replacement demand at a higher level. Engineering has an important stake in the cotton textile industry.

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Japan's Good Intentions

The engineering industry has never been quite as sensitive to Japanese competition as, say, the Lancashire textile industry. The capacity of Japanese draughtsmen to copy engineering designs (to mention only one of the items of Japan's stock-in-trade for competing with highly industrialised countries) is still vivid enough,

however, in the recollection of the older generation of engineers in this country. The latest Anglo-Japanese Sterling Payments Agreement, which is in effect an extension of one already in existence, will therefore be viewed by engineering concerns with some hard-headed reservations. British engineering will not lose under the terms of the agreement which have just been re-negotiated, but there is little indication as yet as to how far it will benefit.

On the British side, renewal of the agreement has been conditioned by a desire to prevent Japan from building up large sterling balances. This accumulation has in fact been going on for some time until recently, and has been the outward manifestation of a pronounced tendency for the Japanese to sell in the Commonwealth market and buy outside the sterling area. The Japanese Government has given assurances under the new agreement that it intends to allow most sterling area products to compete in the Japanese market on the same terms as non-sterling goods. The control of invisible payments is also to be relaxed to some extent. British colonial territories will continue to import Japanese goods as they require them while discrimination against sterling area imports is to be reduced. From information available so far it would appear that the immediate benefit for British exports is likely to be for textiles, whisky and confectionery. How far the engineering industry will benefit from the new arrangements will depend on the degree of assiduity with which British concerns seek business in Japan and the extent to which the Japanese carry out their undertaking not to discriminate against sterling area goods.

To judge from the figures for Japan's balance of payments issued by the Bank of Japan, that country's payments surplus with the sterling area has fallen off considerably in the last few months. It may be, therefore, that judged entirely from the basic problem of preventing Japan from accumulating large quantities of sterling, the corrective measures have already been taken. If this should be so, the whole agreement, is not likely to increase the volume of business for British industry, and is thus very much a matter of good intentions.

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Germany's Way

The German boom is continuing—at an increasing pace. In a speech to the West German Parliament, the Minister of Economic Affairs, Dr. Erhard, quite failed to emulate Mr. Butler, as some had anticipated he would do. His main concern is to increase the availability of goods of all types, to produce an industrial climate where high demand and high investment lead to mass-production, lower costs, reduced prices and higher real wages. His problems are not to reduce a trade deficit but to get rid of an export surplus ; not to curb production for the home market but to make sure that goods are available at the lowest possible prices. With this in mind, he cut tariffs on goods needed for agriculture and building by 50 per cent., proposed to cut tariffs on tools and implements needed in shops and handicraft and to lengthen the building season from nine to eleven months. Dr. Erhard made clear his Government's intention to import foreign labour in " critical " branches of industry and to lower excise duty " in all cases where there is certainty that the public will benefit fully and permanently from the resulting lowering of costs."

The present level of investment, which at 27 per cent. of the gross national product is claimed to be " a record level by international standards," is not to be reduced but will not be allowed to expand much more; and there are proposals to delay public works programmes and to advise companies controlled by the Federal Treasury to postpone plant expansion. In view of the growing shortage of labour and the tendency for wage levels to rise, a need for more drastic action may yet arise. To " maintain the boom but curb excesses " is the Government objective, and the main excess—the tendency of German manufacturers to form price rings and generally take advantage of the relatively low taxation—may be hard to curb even with a most liberal import policy.

From the British point of view, the latest tariff reductions are most welcome and should enable manufacturers to enter the German market, particularly with tractors and agricultural machinery, fertilisers, building materials and hardware, electric stoves and a number of other items included in the list of tariff cuts. It should not be forgotten, however, that Western Germany is spending almost nothing so far on rearmament and is therefore in a most favourable position in international trade; nor is it yet a welfare state. So far, Dr. Erhard's policy has been in the main successful, and production is rising without too much inflationary pressure.

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Pipes for Canada

A great deal of thought and organisation has been put into the engineering industry's approach of recent years to the Canadian market. The carefully planned approach to the St. Lawrence Seaway project is well known. In addition, a number of valuable contracts have been obtained by civil engineering firms and the heavy electrical engineering industry on the other side of Canada, in British Columbia, where industrialisation is going ahead rapidly. Successes have also been achieved in the prairie provinces of Manitoba, Saskatchewan and Alberta where the development of the road system and further electrification have opened up prospects of good business, in addition to the boom conditions which have developed in Alberta since the oil industry began to expand on a significant commercial scale.

From time to time major successes are recorded. Last week it was the news that the South Durham Steel and Iron Company had obtained a contract worth £4·3 million to supply 67,500 tons of 30 in. pipes for the transmission of natural gas in North West Canada. This contract is indeed unique, being the largest single contract ever won by a British company in Canada. The contract is with the Bechtel Corporation, which is responsible for installing the gas scheme in conjunction with West Coast Transmission. The pipes are to be produced at a new plant at Stockton-on-Tees which is rated at 150,000 tons of capacity per year and is to be officially opened by the President of the Board of Trade on November 25. It is interesting to notice that the chairman of the company, Mr. Chetwynd Talbot, said last week that they could not have gone ahead with the contract unless they had been sure of their steel plate supplies which are being made by the company.

This contract is a most encouraging sign. British industry is now recognising that the Canadian frontier does not end at Winnipeg and begin again at the Rocky Mountains. Of late, trade fairs and propaganda have played a useful part in acquainting British industry with the opportunities for development in the prairie provinces of the Dominion, and the provincial Governments have made it clear that they will encourage British enterprise in an endeavour to open up its contacts in this part of Canada. There are clear signs that British industry, notably the engineering industry, is aware that the last frontier in Canada has gone and that capital development need not be left to unchallenged exploitation by the United States.

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Always Another Profit for Gas

In the year ended March 31, 1955, the gas industry achieved a net surplus of almost £2·5 million, making a cumulative surplus of almost £11 million since the industry was nationalised six years ago. The report for the year is a model of informative exposition and discretion; not for the Gas Council any treasonable, graphic complaints about the incidence of hire purchase restrictions on its gas appliance business—though there is plenty of evidence that the restrictions re-imposed last February have seriously reduced hire purchase sales without a compensating increase in cash sales. This blow seems to have been taken rather in sorrow than in anger.

Gas has had both a prosperous and an eventful year. During the financial year under consideration 21 new plants were at work or on order for the complete gasification of heavy oils. This effort by the industry to offset the consequences of rising coal prices has been taken a step further since the financial year ended, with the arrangement now made with the British Petroleum Company, Limited, to supply gas from its new Isle of Grain refinery. An investigation is going on into the technical possibilities of transporting liquefied natural gas to this country from such areas as the Middle East, but the Gas Council is guarded in its remarks on this development. The drilling programme to find natural gas in this country has now used about half of the budgeted £1 million, mostly on drillings in the south of England, and an exploratory well is to be bored in East Yorkshire late this year or early in 1956. A panel is investigating methods of increasing the coke available for sale, especially to domestic consumers. In the Gas Council's opinion, if the industry were given enough suitable coal it could expand its production and sell gas and coke sufficiently to halve the smokeless fuel problem of the " black " areas within 10 to 15 years.

Throughout the report runs the industry's preoccupation with rising prices of coal. The bill for coal at pit-head prices is now about £47 million a year more than it would have been at the prices in operation at the beginning of 1949. Fortunately, significant economies have been achieved: the report points out that if the output of gas and other products during the latest financial year had been produced at the efficiency of 1948, the equivalent of an additional 1¾ million tons of coal would have been required. One important aspect of efficiency is the continued integration of works. Manufacture ceased at 83 works during the year and there are now 785 works in operation compared with 1,050 on vesting day. One consequence of this has been a higher output per operative: between 1952 and 1954 sales increased by 5 per cent. while employment was reduced by 3 per cent.

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Mechanising Coal Delivery

The time to mechanise tradition-bound manual labour is now, when reactionary opposition is lessened by the happy consequences of full employment. Yet in many industries the opportunity is not being grasped. The retail coal trade is having great difficulty in retaining its coal heavers and delivery men. An Oxford firm with 7,000 customers has been obliged to discontinue the retail distribution side of its business. But very few firms have taken steps to install modern plant to overcome the difficulty.

Now that the National Coal Board supply standard grades of coal, it is absurd that individual wagons should continue to travel from colliery to local coal merchant and then be out of traffic for several days until they are unloaded by hand. To make matters worse, the coal merchant usually unloads the small wagons first and retains the modern large-capacity wagons as long as possible. A 16 ton wagon is an economical coal store—economical, that is, for the coal merchant but not for British Railways or the nation.

Is there any valid objection to the construction of hoppers under railway tracks, so that wagons can be discharged quickly and returned to traffic ? One or more hoppers for each grade of fuel are required. There are certainly no engineering difficulties. Spokesmen for the coal merchants have said that present controlled profit margins are unfavourable. If that is the only obstacle perhaps they will badger the Government.

THE MOTOR-CAR COMPONENTS INDUSTRY

(2) EXPANSION SCHEMES AND DIFFICULTIES

Concluded from page 524

The first part of this article, published on page 524 in the issue of October 14, contained a statistical description of the motor-components industry and a discussion of the main problems arising from the considerable expansion of capacity planned by motor-vehicle manufacturers. This part is mainly concerned with some of the industry's special problems to which attention has been drawn by companies who supplied information to ENGINEERING. To name only some of them, there is the considerable pressure from their few large customers to lower costs (which in some cases has meant abnormally low profit margins), the slow progress of standardisation, the growing scarcity of certain materials and problems relating to the sales of spare parts. Under such headings it is possible to make fairly valid generalisations but, as the reader is doubtless aware, the so-called motor-components industry included manufacturers of rubber, leather, steel castings, stampings and forgings, instruments, electrical accessories, bearings, and many other quite distinct products. Many of the manufacturers in this hotch-potch of trades also supply other industries with products.

ORGANISATION AND COMPETITION

The organisation of the motor-car industry, where five companies account for some 90 per cent. of total vehicle output, has had a considerable influence on the companies which supply them with components which account for some 50 to 60 per cent. of the ex-works value of a vehicle. Since the war the degree of concentration in the motor-vehicle industry has been increased by the amalgamation of Nuffield and Austin in the British Motors Corporation, but even before the war 85 per cent. of the number and 60 per cent. of the value of total motor-vehicle production was in the hands of six companies. This has meant that most component manufacturers have only a few customers for the bulk of their output—components for cars, vans, light trucks and agricultural tractors—and some are selling over half their products to two or three companies. This has had three main consequences, one or more of which are at the root of the components industry's main problems. They can be summed up in four words: concentration, low profitability and diversification.

There is among motor manufacturers more competition than is normally met in British engineering. B.M.C., Ford, Rootes, Standard and Vauxhall are all the time sparring for a fight which is expected sooner or later on the home market, and are all exposed to severe foreign competition overseas. It has long been accepted, therefore, that the big business they have to place will be placed at the lowest possible prices, and it is generally true to say that component manufacturers make only a nominal profit on products sold for incorporation in new vehicles. Such sales are estimated currently to account for some 55 to 60 per cent. of the global output of the components industry. Profits are earned in the main, therefore, on the sale of spares to the motoring public through agents, factors and garages, i.e., on less than 45 per cent. of total output of motor components. But the picture is even less rosy than this: there is a marked tendency on the part of motor manufacturers to press for the direct sale to them of as many spares as possible, at prices which often differ little from the prices paid for original equipment. The spares are then sold through the motor manufacturers' own agents. In all cases where the component manufacturer does not possess a nation-wide distribution network of his own (if he is to sell his own spares abroad, he needs a world-wide network), he finds it exceedingly difficult to resist the motor manufacturers' pressure, for they have an obvious interest in having all spares and components for their vehicles readily available wherever they are required. The extract in the first article from a statement by the chairman of the Glacier Metal Company, who make plain bearings, showed that some quite large companies can thus be driven to profit margins lower than they require to sustain healthy growth and expenditure on the research and development that is necessary for progress in component design. The component manufacturers' struggle to overcome these difficulties has led them on the one hand to grow as strong as possible by reducing competition in their own specialised fields and on the other to diversify their output and secure a broader basis for their activities. A combination of both these objectives enables them to sustain the distribution organisation necessary to offer the high standard of service and spares availability that is required.

Although there are over 650 firms in the motor-components industry, the bulk of motor components and accessories are produced by relatively very few firms. In general, engines and bodies are assembled by the motor manufacturers themselves who normally carry out all the machining operations but buy a substantial proportion of the castings, forgings, stampings, etc. There are exceptions, such as Ford, who have very large iron and steel foundries and even a rolling mill for spring blades and other light rolled sections. Some make components which are generally bought out, such as, for example, shock absorbers, wheels, radiators. On the whole, however, there is no trend towards vertical integration in the motor-vehicle industry; body building has become so intimately tied to car design, and assembly with the growth of integral chassisless construction, that most large manufacturers own body-building companies, Pressed Steel being the only large unit which remains independent. In other respects, motor manufacturers have found it preferable not to acquire component manufacturers, mainly because their own requirements might not suffice to secure the full economies of scale they need to keep down costs, partly perhaps because they would lose flexibility in adjusting their output to fluctuations in demand.

The degree of concentration in the components industry is remarkable. Joseph Lucas, who supply the bulk of electrical equipment and accessories, as well as batteries, brakes, fuel injection equipment, etc., employ 46,000 people—more than Ford and not much less than B.M.C.; S. Smith and Sons make the bulk of instruments, clocks and radios sold for road vehicles, Joseph Sankey most of the wheels, Wilmot Breedon most of the bumpers and door fittings. Triplex for windows, Armstrong Patents for shock absorbers, James Booth for non-ferrous metals, George Salter for springs, I.C.I. for leather cloth, and a number of others each supply a major proportion of the motor industry's requirements in one principal line. It would probably not be far off the mark to say that 15 to 20 firms in fact supply between 70 and 80 per cent. of all components and accessories purchased by motor manufacturers and account for a large proportion of the 150,000 to 200,000 people employed in making them. There are of course certain industries for whom the motor manufacturers are not the main source of business, such as, for example, rubber, leather cloth and bearings—although even in their case the motor industry is a large customer and will, if its rate of growth is maintained, be a major one by 1960. The same of course applies to the steel industry, where one-third of the total supplies of sheet are sold to motor manufacturers, a proportion which may well exceed one-half within five years.

Those component manufacturers who have achieved a high rate of output of motor components are usually also important suppliers to the aircraft and cycle industries, probably to the extent of a third or more of their total output. One of the points made in the first article was that as armament orders for aircraft fall off, capacity will be available for motor-vehicle components. While this is generally expected, it will be far from welcomed by the industry who find that, in general, the profit margins on aircraft components are larger than are obtainable on motor-vehicle components, even if the profit on the sales of initial equipment and on the sale of spares is averaged out. The downward trend of aircraft production is therefore likely to provide an additional incentive to the component manufacturer to diversify and so secure some independence from the motor industry.

There are a good many instances of this since the war—for example, Joseph Lucas have entered the gas-turbine equipment field; Wellworthy, who are major producers of piston and piston rings, are tooling up to make superchargers for Diesel engines and heat exchangers for atomic plant; Simms Motor Units make counterpoise lamps; Pressed Steel have for some time been prominent manufacturers of refrigerators and railway equipment, and their chairman made the point in his last speech to shareholders that "we have good diversification and do not depend altogether on motor cars; although they represent our most important business"; Armstrong Patents make heli-coil inserts which, they say, have most promising business potentialities "in a wide variety of industries." It would probably be difficult to find among the motor-component manufacturers a single company of any size which is not supplying other industries. This trend towards diversification does not necessarily make for efficiency. In most cases—particularly where all products are made in the same factories utilising the same machine shop facilities—it is a high price to pay for independence, but those companies which gave us information appear very glad to pay it. Diversification will go on so long as the fear of dependence on very few large customers persists; this is a very understandable fear when the loss of one customer could mean a fall of 20 per cent. in the volume of orders. On the whole, however, diversification is unlikely to make for efficiency, if only because it divides the attentions of top management. Another result of the low profit margins allowed on initial equipment is the endeavour of companies to design accessories to offer as an extra or an improvement for vehicles on the road. Lucas's new windscreen washer is an example of this, and there are a number of others.

INCREASING OUTPUTS

Among the replies received in answer to the enquiries made concerning expansion of capacity, a number mention that they have either greatly expanded output without substantial increase in the number of workers, mainly through the installation of the most modern plant and improved organisation. The extent to which this would appear to be due to the use of modern equipment rather than to a higher level of output is surprising, though the two are closely associated since certain machines, such as those of the automatic transfer type, can only be used if very long production runs of standard items are available. The following paragraphs consist of extracts from company's statements illustrating the importance attached to productivity and show something of what has already been achieved. They are divided into broad product groups.

Tyre manufacture for the motor and aircraft industries is a major activity on which it is estimated that some 40,000 to 50,000 workers are employed. The Dunlop Rubber Company provided a most interesting account of the new methods that they have latterly introduced: New compounding equipment has been introduced to

provide a continuous sequence of operations with automatic control, thus saving the labour needed to cut and handle individual sheets off the mill. The traditional vulcanisation and moulding processes have also been revolutionised, the new equipment considerably reducing the time cycle by performing functions of inflation, temperature control, cooling and cover extraction, in a manner that is in the field of automation.

Dunlop are not alone in expanding and modernising their plant. The Goodyear Tyre and Rubber Company are progressing with an £11 million investment scheme "prompted mainly by the expansion of the motor industry and by labour shortage." It should not be forgotten, however, that the demand for tyres is based to a major extent on a replacement trade, which is estimated to account for well over a third of the total value of motor accessories and components sold as spares.

Information on wheel manufacture was provided mainly by Joseph Sankey who supply probably about three-quarters of all wheels used. They were first in the field with a pressed steel wheel and now make about 12,000 a day. They report: "We are at the moment in the process of equipping a completely new press shop for the production of panels, we have just completed a new and expanded tool room and an addition of 90,000 square feet of factory space is at present under construction adjacent to our wheel division. These are just the major projects under way at the moment. Further plans have just been approved for considerable extensions over and above this."

The Pressed Steel Company are building a complete factory of 300,000 square feet near Swindon on a site of 138 acres. Richard Berry and Son, the spring-making subsidiary of Messrs. J. Brockhouse, emphasised the advantages obtained from modern plant and draw attention to the immense reserve capacity that exists in the industry if multi-shift work is adopted. By 1950, Berry's were making 500 to 600 tons of road springs every month. The new factory, built in 1953, to replace the old works, occupies very little more area, but due to the fully mechanised flow lines has more than twice the capacity of the old plant. Production has already risen to 800 tons per month and plant is now available to meet the 25 per cent. rise anticipated by the motor industry for next year. George Salter and Company, who are probably the largest makers of springs in the country, are building a new mass-production works for the production of standard springs yielding considerable economies in labour, and which will, they claim, be the largest in the country.

A similar picture is obtained from the other information received from manufacturers of brakes, steering gear, pistons, bearings electrical accessories, instruments radiators, etc.

Girling, Limited.—"At this time last year our brake production was in the region of 50,000 brakes per week, and at present it is approximately 70,000 . . . . By this time next year we aim at producing 100,000 brakes per week to meet the increasing demand from motor manufacturers. This reorganisation will also affect damper production and we reckon to double our output for cars, motor cycles and commercial vehicles in the ensuing year."

Ferodo, Limited.—An extension of 83,000 square feet is being built which will bring the total area of the works to approximately 630,000 square feet, the largest single factory in the world devoted to the manufacture of brake and clutch linings.

Wellworthy Piston Rings, Limited.—A total expansion of nearly 70,000 square feet is either in hand or planned, in large part to increase capacity for the manufacture of pistons and piston rings.

Glacier Metal Company, Limited.—"Three years ago, we opened an extension to our Kilmarnock plant which more than doubled its size by the addition of 70,000 extra square feet. During the last two years, we have steadily installed in this space sintering, rolling, electro-deposition and impregnation plant for the production of the various types of bi- and tri-metal coiled materials which form the basis of production of crankshaft bearings and bushes to-day, together with the building of a new strip mill in our London plant which is just starting operations. These additions have expanded our capacity for the production of strip bearing materials over the last two years by some 200 per cent. . . . We have already laid down an additional six production lines for the manufacture of thin-wall bearings, and, by Christmas, 1955, we shall have laid down 11 additional lines. . . . By that date our capacity for the production of half-bearings will be about 250 per cent. of what it was two years ago. The manufacture of wrapped bushes has been expanded in a similar way to match the output of half-bearings."

The Hoffmann Manufacturing Company, Limited.—"We have spent freely over the past few years and at the moment are committed to heavy capital expenditure. Expansion of our plant is limited by the present availability of labour. This expansion is going on but not on a spectacular scale. We are concentrating more on the provision of the most up-to-date plant, coupled with constant research into methods to increase production without detriment to quality and conserving labour to the utmost degree."

IMPACT OF STANDARDISATION

Two points of considerable importance remain to be discussed: the slow progress being made with the standardisation of specifications and the growing shortage of certain materials, particularly spring steel, light rolled sections and sheet. A revealing comment was made by Dunlop Rubber concerning the lack of standardisation: "All-in-all, there are many more sizes and types in the range of tyres to be dealt with to-day than ever before in the whole history of the tyre business. One can only hope that some approach to standardisation will eventually be forthcoming."

In their case, the increase in the demand for non-standard tyres results from the growth in the production of sports snd racing cars which have been one of our best dollar earners. But this is not an isolated instance: a number of component manufacturers have pointed out that the demand for a wide variety of specifications is effectively preventing them from adopting the most up-to-date continuous-production methods. This applies also to the demand for steel where the frequent interruptions for resetting are keeping the rolling mills' output substantially below their optimum. As competition becomes more acute, particularly in overseas markets, component makers may find it necessary to increase the price differential between standard and non-standard items. Such rule-of-thumb methods can only be used by the largest companies and even then not with their major customers. It is encouraging to hear, therefore, that the Society of Motor Manufacturers and Traders has recently enlarged and reorganised its standardisation committee, for the adoption of standards may be the industry's best way to reduce costs. There are, of course, serious snags in taking such a course—one is that to go "far enough" may take away too many of the differences between the various mass-produced cars; another is that the application of a heavy price differential could kill the specialist car industry whose needs are often quite different and who have for years been in the vanguard of the industry both in design and development, as well as the testing ground for the new ideas of component makers. Despite the difficulties much progress can be made, even if only within groups of companies now producing a wide range of models.

There is a sharp contrast between the British manufacturers' practice in buying components and that of the Continental manufacturers who make a much larger proportion of their own. Their task is, of course, made easier by the much longer runs of standard models: in 1954 Volkswagen made 202,000 identical cars, Renault 123,000 4 CV, Opel 86,000, Simca 81,000, Arondes and Peugeot 73,000 "203." This compares with 73,000 Morris Minors, the biggest single model output in the British industry, 68,000 Hillman Minx, 61,000 Austin A.40 and 59,000 Austin A.36. There is, of course, a great deal for inter-model standardisation but few would claim that this gives the full advantages of single model production. The Continental practice of making a higher proportion of their own components differs from American practice, although American output of many standard models is considerably higher than even Volkswagen's. American manufacturers may wish to insulate themselves against as much of the seasonal and other fluctuations in demand as possible, though advantages of scale go far beyond ¼ million units a year. There is little doubt that longer runs of car models on the continental scale would help to reduce component manufacturers' costs, but this is not a new problem and one which the British motor industry has always been reluctant to tackle, especially after the relative failure of the single medium-size models produced after the war.

The shortage of materials is mentioned by several companies: it is so far mainly of sheet steel, light rolled sections and spring steel, though it is spreading rapidly to other types. The following comment from Brockhouse is typical: "Our gravest concern at the present time is the supply of steel in all its forms. Steel mills to-day are quoting nine to twelve months against specification. The worst feature, however, is that there is no guarantee of tonnage even at this very protracted delivery."

The steel situation was discussed in Weekly Survey last week, "Steel Brake on Output," and is also the subject of this week's leader. No immediate improvement is likely, but the situation should not get very much worse if imports can be obtained and if the steelmakers can get all the raw materials they need this winter. The fact that manufacturers are building stocks to safeguard the flow of production is making the general supply position worse than it need be. Such a policy is, on the other hand, quite understandable since in the United States steel consumers are overwhelming the mills with orders, many of which cannot be delivered until next spring. It may well be, therefore, that we shall not be able to increase imports further, or even maintain them at the present level.

* * *

SIGNALLING CONVERSION ON EASTERN REGION

Problems of Electrification

The electrification of the lines between Shenfield and Chelmsford, and between Shenfield and Southend (Victoria) in the Eastern Region of British Railways, is necessitating a modification of the colour light signalling which was installed on both sections before the war. Direct-current operation of the track circuits, which is not suitable for use with direct-current traction, is being replaced by controlling equipment of the alternating-current type, although the existing signals will be retained.

The work involved will include the provision of impedance bonds between adjacent track circuits to provide a path for the traction return current. The telecommunication circuits on both sections and the signalling circuits on the Shenfield-Chelmsford section, which are at present run as open wires on poles, will be replaced by underground cables laid in concrete troughing, so as to eliminate inductive interference. New equipment and relay rooms will be added at Ingatestone and Wickford signal boxes and the new relay and other apparatus will also be housed in existing signal boxes at Chelmsford and Southend.

The contract portion of this work is being carried out by Siemens and General Electric Railway Signal Company, Limited, East Lane, Wembley, to the requirements of the Signal Engineer, Eastern Region, British Railways.

I.MECH.E. PRESIDENTIAL ADDRESS

MR. P. L. JONES PROPOSES FULL-SCALE MARINE PROPELLER TESTS

In his presidential address to the Institution of Mechanical Engineers last Friday, Mr. P. L. Jones, M.C., B.Sc., Wh.Ex., brought to a review of the shipbuilding industry a freshness of outlook which no doubt derives from the fact that his early years as an engineer were spent in other branches of engineering, including locomotive work and teaching.

It was common knowledge, he said, that a great deal of time and money had been spent in recent years on research on the design of propellers. A very large number of systematic tests of models had been carried out in the various laboratories and tank installations throughout the world, and this work was continuing. No one who had witnessed some of the beautiful and fascinating experimental work of propeller research could fail to be impressed by the enormous amount of skill and ingenuity involved. Nevertheless, at the risk of being considered a complete Philistine, he confessed that as a practical man he thought such work left a lot to be desired. It seemed to be a matter of very grave doubt as to how far the results obtained from a model propeller of diameter 15-20 in., running at several hundred r.p.m. could be applied to a full-size propeller of, say, 18 ft. running at about 100 r.p.m. or less. For many years he had felt there was a risk of considerable error in this practice and that the shipbuilding and shipping industries would be wise to give very careful consideration to the question of providing facilities for full-scale propeller tests under conditions as nearly similar as possible to those which existed behind an actual hull. He was aware that the cost of equipping and running such an experimental station would be extremely large but, having regard to the importance of the question, it was, he thought, quite certain that the money would be well spent. The poorly designed propeller was something which the shipping and shipbuilding industries simply could not afford. It resulted in wasteful consumption of fuel and unnecessarily large machinery bunkers, etc. No doubt the law of diminishing returns would eventually apply to full-scale propeller research, but before that stage was reached considerable improvement could be obtained without much difficulty. The great cost of the testing equipment would soon be repaid and steady improvements in efficiency could be counted on for some years to come.

COST OF INCREASED SPEED

Mr. Jones dealt with the criticism that shipbuilding and marine engineering were slow to change. Speaking only of merchant ships he said that the choice of speed for a new ship was influenced by all sorts of considerations, many outside the province of shipbuilders and marine-engine builders, and could be properly assessed only by the shipowner. The shipbuilder could inform the shipowner of some of the matters which affected this question, such as s.h.p., cost of machinery and hull, fuel consumption, weight and space occupied by the machinery, etc., but it was the shipowner alone who could give due weight to the many other issues involved. Ships could not escape into a more rarefied medium and thereby reduce the resistance to motion. They had always to contend with media of almost the same density, waves of the same average size, winds, currents, etc., which were substantially the same year after year and century after century; they had to plod along in water in which resistance to motion was proportional to the nth power of the speed, where n was always more than 2 and perhaps as much as 4. Horse-power was proportional to the speed to the power $n + 1$, and fuel cost for a given distance was proportional to speed to the nth power. Thus, increased speed could be achieved only by increased power. Higher power meant not only larger and more expensive machinery, but also heavier fuel cost and increased weight and space and bunker capacity. All these factors were taken into consideration by shipowners and the speed finally decided upon was the result of extremely careful and intelligent weighing up of the pros and cons. The fact that the speed of ships had not shown any spectacular change in recent years was in no way due to the failure of naval architects or marine-engine builders to live up to their responsibilities. They could give the shipowner anything he required in reason, provided he was not only prepared to pay for it but would put up with the consequences in other directions.

Throughout his address, Mr. Jones contrasted and compared marine and land engineering practice. He recalled the difficulties experienced at first in applying steam turbines to ships. The introduction of gearing had overcome the difficulty that a turbine was a high-speed machine and the propeller was essentially a low-speed device, but then troubles with fractures of gear teeth developed, and when corrosion of turbine blades was also experienced the marine turbine received a setback from which it took years fully to recover.

The development of the marine oil engine had been remarkable. After several years of setbacks and disappointments a few dependable types were evolved. This all-important stage having been reached, marine engine builders directed increasing efforts to reducing the cost of production and improving the efficiency and, as a result, the marine oil engine was to-day one of the most widely adopted of all methods of propulsion, and its overall economy higher than that of any other prime mover in existence.

In view of the wide application of gearing to marine steam turbines, some people were surprised, he said, that gearing of oil engines had not been adopted more widely. The reasons were quite simple. The direct-drive turbine was not only prohibitive in cost and weight, but extremely inefficient, and the turbine would not have survived in marine practice without gearing. With the oil engine, however, gearing, while reducing the weight, did not produce an improvement in economy; in fact, owing to the losses in the gears and couplings, there was a reduction in efficiency of some 5 to 6 per cent. In some cases this loss was partly offset by the fact that the propeller efficiency was higher because a lower speed of revolution could be adopted. However, with fast running oil engines the fuel consumption per b.h.p. was usually appreciably higher than with slower running machines and, in consequence, the geared oil-engine ship required to carry more bunkers and that offset, to some extent, the saving in weight. At the present time, the cost of the geared oil engine was considerably higher than that of direct drive. This disadvantage might be overcome if the speed of the engines could be sufficiently increased and their weight thereby correspondingly reduced. The great advantage of gearing oil engines was the reduction in head room thereby achieved, which was an important consideration in some types of ships. Having regard to all this, however, and the advent of the gas turbine, it was doubtful if there would be a great future for the geared oil engine.

HIGH EFFICIENCY

After pointing out some of the peculiar difficulties encountered by marine engineers, he said that in spite of all these difficulties the efficiency of some marine steam installations was at least as good as that of most land installations of comparable size. In some recent ships in which the power was only 8,000 s.h.p., the thermal efficiency in service was over 25 per cent., which was extremely satisfactory. As regards oil engines, the efficiency was about 37–38 per cent., and nothing yet achieved on land could surpass this.

Perhaps the greatest disadvantage with which the marine designer had always had to contend was that of obtaining reliable observations. The loading and trim of a ship were different during a trial trip than in normal service. Of recent years, however, under the aegis of the British Shipbuilding Research Association and with the co-operation of certain shipowners, observations had been taken on loaded ships in service operation.

Commenting on the role of the classification societies, such as Lloyd's, and the great deal of work which is now the province of the British Shipbuilding Research Association and Pametrada, Mr. Jones said: "The present time, in fact, can be regarded as the age of co-operative research in the marine field . . . . This set-up has many good points, but it also has others which are not so satisfactory. It is rather like putting too many eggs in one basket, and it has the effect of reducing to some extent individual initiative and research in design. On the other hand, it has probably saved many millions of pounds by eliminating useless and duplicated effort and over-intense competition such as that which was so characteristic of the shipbuilding industry in the 1920's."

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NUCLEAR ENERGY FOR POWER AND TRANSPORT

Speeches at I.Mech.E. Dinner

That atomic energy had arrived just in time to save Britain from the most serious difficulties she had yet faced was the opinion expressed by the Marquis of Salisbury, K.G., when proposing the toast of "The Institution" at the annual dinner of the Institution of Mechanical Engineers, held in London on Thursday, October 20. Lord Salisbury, who, as Lord President of the Council is responsible to Parliament for all Government-sponsored research, went on to say that, since the standard of living was almost proportional to the consumption of power, if we were to double our standard of living there must be an equivalent rise in the generation of power. In that light we had to recognise that coal production was almost stationary and that it was quite impracticable to consider an increase in oil imports.

The importance of atomic energy could not therefore be underrated, and Lord Salisbury congratulated the Institutions which had combined to form the British Nuclear Energy Conference—a combination which he thought to be unprecedented and which would be invaluable to the country.

A common theme of atomic energy ran through all four of the speeches and when the President, Mr. P. L. Jones, replied to Lord Salisbury, he referred to the future impact of nuclear energy on marine propulsion. He foresaw the time when nuclear reactors would be built in closed circuits with high-pressure turbines; all marine engineers would appreciate the advantages that would accrue from having bunkers that would remain constant in weight—a condition not experienced since the days of sail!

Replying to "The Guests," Sir Christopher Hinton pointed out that the nuclear power stations being built were about two-thirds conventional equipment and only one-third involving plant that was of a peculiarly new design. The leading position now held by the United Kingdom was not due to the development of something inherently new, but rather to the ability for adapting existing methods to the needs. Power stations being built for the Central Electricity Authority involved a relatively high weight of plant for each horse-power generated; with time that proportion would be lowered until mobile platforms—ships, locomotives and even perhaps aeroplanes—would be fitted with nuclear energy propulsion units.

Obituary

MR. GUY L. MURRAY

Colour Control for Machine Tools

We record with regret the death of Mr. G. L. Murray, M.I.Mech.E., which occurred on October 7.

Guy L. Murray was born in 1888, at Trentham, Stoke-on-Trent. In 1906, he was apprenticed to the locomotive engineers Kerr, Stuart and, Company, Limited, Stoke-on-Trent, and in 1912 he was appointed assistant works manager. Two years later, he was promoted to works manager. Kerr, Stuart and Company at this time employed 1,000 men and were carrying out large contracts for railways at home and overseas.

In 1915, Mr. Murray entered the machine tool field as works manager of Joshua Buckton and Company, Limited, Leeds, well known for their testing machines as well as for light and heavy machine tools. He remained with this company until 1924, when he was engaged by W. T. Avery and Company, Limited, as a consultant on special work. The following year he returned to the locomotive engineering world as works manager to Manning, Wardle and Company, Limited, at Leeds.

From 1927 to 1931, Mr. Murray was works superintendent of the carriage and wagon works of the Sudan Government Railways, at Atharen. These works employed 2,000 men, and to overcome the difficulties of the natives in interpreting European figures and letters, Mr. Murray devised a system for controlling the use of limit gauges by means of colours and combinations of colours. By this means he was able to obtain high-class work from unskilled labour. This system, and its later applications to the control of machine tools, which he developed while managing director of Murray Colour Controls, Limited, between 1934 and 1937, were described in detail in the February 8 and 22, 1935, issues of ENGINEERING (vol. 139, pages 141 and 197).

In 1939, Mr. Murray became a member of the teaching staff of Cheltenham College, where he started and developed the College engineering department. His personal contact with industry led to the founding of engineering scholarships at the college by firms such as Thomas Firth and John Brown Limited, of Sheffield. After leaving Cheltenham College in 1950, Mr. Murray continued to work as a consulting engineer until his death.

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MR. F. W. SHILSTONE

Planning Industrial Estates

We also regret to record the death of Mr. F. W. Shilstone, which occurred on Tuesday, October 11 at the age of 63.

Frank Walter Shilstone was born on May 1, 1892, and received his early education at St. Joseph's College, Darjeeling, India. From 1911 to 1914 he attended the City and Guilds Central Technical College, where he studied civil and mechanical engineering, and in 1919 joined the firm of Kennedy and Donkin with whom he was employed as assistant shift engineer at the Grove Road power station in London. He was later engaged with the same firm of consulting engineers in the design of rolling mills in Birmingham; as assistant engineer in supervising the erection and equipment of the Portobello power station in Edinburgh; and on similar work in connection with the building of a power station in Calcutta. Subsequently he had sole charge of the design, construction and supervision of the erection of a power station for Michael Nairn and Company, and from 1927 to 1930 he was engaged on the design of 33kV switchgear with a rupturing capacity up to 500 MVA for the British grid.

In 1930 he was appointed chief engineer of the South West England and South Wales Area of the Central Electricity Board in which position he was in charge of the design and control of contracts for substations, transformers, switchgear and overhead lines. He was subsequently engaged as chief engineer and managing director of the Town and Factories Development Company, Limited, with whom he was responsible for the preparation of schemes for industrial estates, including power stations, roads, railway sidings and land drainage. In 1940 he re-joined the staff of Kennedy and Donkin and was still a member of their staff at the time of his death.

Mr. Shilstone was elected an Associate Member of the Institution of Civil Engineers in 1921 and was transferred to the class of Members in 1938. He joined the Institution of Electrical Engineers as an Associate Member in 1933 and became a Member five years later.

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We regret also to record the deaths of:

MR. ALFRED ROBERTSON, Hon.M.I.Mar.E., M.I.N.A., on September 22 at the age of 75. Mr. Robertson, a consulting engineer and honorary treasurer of the Institute of Marine Engineers, had also a record of 27 years in public service in the City of London.

MR. WILLIAM FINDLAY PEARCE, M.I.Mech.E., M.I.H. & V.E., at Urmston, Manchester, on October 7. Mr. Pearce, who had attained the age of 65, retired on April 30, 1955, from his position of chief engineer and general manager of the National Boiler and General Insurance Co. Ltd. He joined the company as an inspecting engineer in 1920 and was transferred to the head office staff in 1924. He became chief engineer of the company in 1933 and chief engineer and general manager in 1936.

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Letters to the Editor

STEAM ROAD LOCOMOTIVES

Preservation Society Formed

SIR, As a result of the growing interest in steam road locomotion, a public meeting was held recently at Redruth in Cornwall, the town in which the first steam locomotive was made by William Murdock in 1784. At this meeting it was resolved to form the "West of England Steam Engine Society" whose primary object will be to organise an annual public rally in some part of Cornwall or Devon at which steam traction engines, steam rollers, steam cars and other old vehicles can be exhibited and seen in motion.

From the amount of support already received it is apparent that there is widespread public interest in such a venture. Its success or failure, however, will largely depend on whether a sufficient number of old road vehicles, especially steam ones, can be brought together for display at these rallies. Several members of the new Society are enthusiastic owners of traction engines and others would gladly renovate an old engine and provide a good and permanent home for it if they knew where one could be obtained. Unfortunately, scrapping of these grand old veterans has been taking place at an ever increasing rate in recent years and now only a few are left. I am therefore wondering if any of your readers know of a steam road vehicle of any type that could be renovated and preserved by our members. There must be several such lying about in out-of-the-way parts of Cornwall and Devon, and if the location and name and address of the owner of these could be sent to me, I should be most grateful and would pass the information on to those of our members who are wanting to preserve such engines.

Yours truly,
J. H. TROUNSON,
Chairman, West of England Steam Engine Society.

Laguna,
Redruth,
Cornwall.
October 20, 1955.

ULTIMATE STRENGTH OF THICK-WALLED CYLINDERS

SIR, Messrs. Crossland and Bones, in your issue of September 30, page 445, point out that the equation used in my letter (your issue of September 16 page 368), is valid for small strains only. This is true. The suggested method, however, is not limited to small strains.

The equation for K′ in my first letter was a hasty attempt to simplify the K′ value, and is admittedly a rather poor choice. The K′ value is developed from:

$$K' = K\frac{1+\epsilon_0}{1+\epsilon_u}$$

$$\epsilon_0 = \frac{\epsilon_u}{(K')^2} \quad \text{small strains,}$$

$$\epsilon_0(2+\epsilon_0) = \frac{\epsilon_u(2+\epsilon_u)}{(K')^2} \quad \text{large strains.}$$

Eliminating ϵ_0 we find :

$$K = \frac{(1+\epsilon_u)(K')^2}{\epsilon_u + (K')^2} \quad \text{small strains,}$$

$$K^2 = \frac{(1+\epsilon_u)^2(K')^4}{\epsilon_u(2+\epsilon_u)+(K')^2} \quad \text{large strains.}$$

These equations are rather cumbersome to work with. As they are independent of the material used, a diagram of the three variables can be made once and for all. If ϵ_u is plotted against K and K′ as abscissae and ordinates, the ϵ_u curves turn out to be of such slight curvature that they, for practical purposes, can be replaced by straight lines. Within limits of $\epsilon_u = 0{\cdot}28$ and $K = 5{\cdot}0$ the following equation can be used :

$$K' = \frac{K}{1+0{\cdot}935\epsilon}$$

where ϵ is the strain at the inside wall.

The equations given in my letters were developed from an engineer's point of view, and on this basis one might take exception to the statement that a pressure equation obtained from tensile tests can never be entirely satisfactory. It is proper for a scientist to demand perfection; an engineer cannot always be so particular, and must often be satisfied with means and methods far from perfect.

The Manning theory, amply supported by Crossland and Bones, is probably as close to perfection as can be expected for the time being. Yet, the engineer who is willing to go through the graphical integration described by Manning cannot use this method directly, when faced with the problem of projecting a thick-walled cylinder, for the simple reason that he does not have available a stress-strain curve of the very material going into his cylinder, and he will generally not get his test specimens until the cylinder is half-way through fabrication. When he finally gets his test specimens pulled, and plots his stress-strain curves, he will often find himself with a number of curves showing variations in properties up to 10 to 15 per cent.

The only approach to the problem is the use of an idealised stress-strain curve plotted through the minimum values of yield and ultimate strength as given in the material specification. Considering the margin between minimum and maximum property values of modern high-strength steels, the engineer can feel quite satisfied with an equation of the type suggested by Van Iterson, Faupel and Furbeck or the writer. But methods as those suggested by Manning, Crossland and Bones will always remain the yardstick with which the engineer will measure the accuracy of his methods. For this reason the new projected tests by Messrs. Crossland and Bones are awaited with keen anticipation.

Yours very truly,
S. M. JORGENSEN.

Foster Wheeler Corporation,
New York, N.Y.
October 20, 1955.

PERSONAL

Sir Bruce White, Wolfe Barry and Partners, 1 Lygon-place, Grosvenor-gardens, London, S.W.1, have taken into partnership, as from October 6, MR. D. P. BERTLIN, M.Eng., M.I.C.E.

MR. J. W. NORRIS, C.B.E., A.C.G.I., A.M.I.C.E., A.M.I.Mech.E., chief inspecting engineer, Crown Agents for Oversea Governments and Administrations, is retiring on October 31 from this post although remaining in the service of the Crown Agents in an advisory capacity. He will be succeeded by MR. W. D. FARRINGTON, B.Sc. (Eng.), A.C.G.I., A.M.I.Mech.E., the present deputy chief inspecting engineer.

MR. A. E. ANDREW, A.M.I.Prod.E., has been appointed superintendent of the main production department of the Metropolitan-Vickers Electrical Co. Ltd., Trafford Park, Manchester, 17. He has succeeded MR. A. J. LESLIE, who will continue to assist the director of manufacture on special problems.

BRIGADIER L. DE M. THUILLIER, O.B.E., A.D.C., chief signal officer, headquarters, Northern Command, has been appointed director of telecommunications, War Office, with the temporary rank of major-general. MAJOR-GENERAL L. N. TYLER, C.B., O.B.E., B.Sc., R.E.M.E., director of mechanical engineering, general headquarters, Middle East Land Forces, has been appointed commandant, headquarters base workshop group R.E.M.E., Chilwell, Nottinghamshire, with effect from January, 1956.

MR. W. STRATH, C.B., M.A., at present serving as a third secretary in H.M. Treasury, has been appointed a full-time member of the United Kingdom Atomic Energy Authority. SIR A. ROWLAND SMITH, chairman of the Ford Motor Co. Ltd., and MR. C. F. KEARTON, O.B.E., a director of Courtaulds Ltd., have been appointed part-time members.

MR. P. L. JONES, M.C., a director of Swan, Hunter, and Wigham Richardson Ltd., Newcastle-upon-Tyne, has been elected chairman of the National Association of Marine Enginebuilders for 1955-56. MR. JAMES FERRIER, chairman and managing director of Rankin and Blackmore Ltd., Greenock, has been elected vice-chairman.

DR. W. R. HAWTHORNE, M.I.Mech.E., F.R.Ae.S., F.R.S., has been appointed Jerome Clarke Hunsaker Professor of Aeronautical Engineering at the Massachusetts Institute of Technology, Cambridge, Massachusetts, U.S.A., for the current academic year. Dr. Hawthorne is on leave from the University of Cambridge where he holds the Hopkinson and Imperial Chemical Industries Professorship of Applied Thermodynamics.

DR. A. PARKER, C.B.E., Director of Fuel Research, has been installed as chairman of the Council of the Royal Society of Health (formerly the Royal Sanitary Institute), 90 Buckingham Palace-road, London, S.W.1.

MR. W. K. G. ALLEN, M.I.Mar.E., A.M.I.N.A., has been elected President of the British Engineers' Association, 32 Victoria-street, London, S.W.1. Mr. Allen is chairman and joint managing director of W. H. Allen, Sons & Co. Ltd. MR. E. W. THOMPSON, M.A., J.P., chairman and managing director of John Thompson Ltd., has been elected vice-president. The retiring President, MR. H. S. BROOM, M.B.E., B.Sc., M.I.Mech.E., joint managing director of Broom and Wade Ltd., has been elected honorary treasurer.

MR. ARTHUR HILLIER, O.B.E., J.P., chairman and managing director of the Sperry Gyroscope Co. Ltd., Great West-road, Brentford, Middlesex, has been created a *Commendatore* of the Italian Order of Merit. He is already a Commander of the Order of Oranje Nassau (the Netherlands) and an Officer of the Legion of Honour (France).

MR. A. C. BREARLEY, B.Met., F.I.M., has joined the board of Catton & Co. Ltd., Yorkshire Steel Foundry, 29 Chadwick-street, Black Bull-street, Leeds, 10, as technical director.

MR. W. H. BATCHELOR has been elected commercial director of the Perry Barr Metal Co., Ltd., Oscott Works, Shady-lane, Great Barr, Birmingham, 22A.

MR. J. M. WILLEY, A.M.I.E.E., M.Inst.W., general manager of Murex Welding Processes, Ltd., Waltham Cross, Hertfordshire, has been appointed to the board of directors of the company.

MR. R. J. FOSTER, D.F.C., A.F.C., has been appointed general manager of British Oxygen Aro Equipment Ltd., formed early last month by the British Oxygen Co. Ltd., and the Aro Equipment Corporation of America.

MR. W. C. IKESON, M.B.E., A.M.I.Mech.E., M.I.Loco.E., M.Inst.Pet., of South Woodford, London, E.18, has been awarded the Howard Prize of £50 for mechanical motive power, by the Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2, for his essay on a new conception of the oil-fired steam locomotive.

MR. A. M. A. MAJENDIE, M.A., F.R.Ae.S., has been appointed President of the Institute of Navigation for the year 1955-56.

MR. R. E. V. JELLIFFE, deputy director of stores, Admiralty, who has been in charge of the branch of the department dealing with oil fuel and the management of the Admiralty tanker fleet, retired on October 15 after more than 41 years of service with the Admiralty.

MR. PETER ALLISTON, A.C.G.I., B.Sc. (Eng.), has been appointed commercial manager of F. Perkins (Canada) Ltd., Toronto, the Canadian Company of F. Perkins Ltd., Diesel-engine manufacturers, Peterborough.

MR. A. S. C. CHATTEY, managing director of A.C.V. Sales Ltd., has been appointed to the board of A.E.C. Ltd., Southall, Middlesex.

MR. NORMAN LEE has been appointed service manager of the British Materials Handling Division of the Yale and Towne Manufacturing Co., Wednesfield, Wolverhampton, Staffordshire.

Mond Nickel Fellowships for 1955 have been awarded to MR. D. H. BUTLER, of the Phosphor Bronze Co. Ltd., MR. R. W. N. DRON, of Rhoanglo Mine Services Ltd., MR. W. F. DUNCAN, of the British Aluminium Co. Ltd., MR. R. H. HANNAFORD, of the British Iron and Steel Research Association, and MR. R. J. HARBORD, of John Lysaght's Scunthorpe Steelworks, Ltd.

MR. A. WILLIAMS-GARDNER, the general sales manager of L. A. Mitchell Ltd., Harvester House, 37 Peter-street, Manchester, 2, has now joined the board of that company as sales director. MR. JOHN MITCHELL, manager of the Sparkler Filter Division, and MR. H. HOULKER, manager of the Industrial Dryer Division, have also been appointed to the board.

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COMMERCIAL

THE BRITISH CYCLE AND MOTOR CYCLE MANUFACTURERS AND TRADERS UNION have removed their offices from the Towers, Warwick-road, Coventry, to 20-23 Lincolns Inn Fields, London, W.C.2. (Telephone: CHAncery 4152.)

JAMES GORDON & CO. LTD., combustion engineers and makers of boiler control equipment, Dalston-gardens, Stanmore, Middlesex, inform us that to improve their manufacturing facilities and to extend the field of their activities they have amalgamated with HALL TELEPHONE ACCESSORIES LTD., Dudden Hill-lane, Neasden, London, N.W.10. At the same time, PANELLIT LTD., a subsidiary company of Hall Telephones has been formed to exploit exclusive licences of PANELLIT INC., a widely known American company.

The secretaries of the BRITISH CHAMBER OF COMMERCE, Tokyo, are now MESSRS. LOWE, BINGHAM AND THOMSONS, whose offices are at Naka 9th Building, 14 Marunouchi, 2-Chome, Chiyoda-Ku, Tokyo

PYE LTD., Cambridge, announce the impending formation of a French subsidiary company, to be known as PYE (FRANCE) S.A.

HEAD WRIGHTSON PROCESSES LTD., Teesdale House, 24-26 Baltic-street, London, E.C.1, have signed an agreement with D. BONALDI & CO., for the manufacture, in Italy, of the Head Wrightson air-cooled heat exchangers.

A new factory is to be built at Birmingham to house the engineering firms of WELDALL AND ASSEMBLY, LTD., and STERN AND BELL, LTD., members of the Triplex group of companies. Two existing factories, at Camden-drive and King-street, in Birmingham, are scheduled for demolition.

To cope with increasing business, the London office of LUMENATED CEILINGS LTD., a subsidiary company of THERMOTANK LTD., has been moved to larger premises at Alliance House, Caxton-street, S.W.1. (Telephone: ABBey 7113.)

POWELL DUFFRYN TECHNICAL SERVICES LTD., 19 Berkeley-street, London, W.1, who are engaged, under the Colombo Plan, in investigating the Neyveli lignite project at South Arcot, have now been appointed by the Government of India to draw up detailed plans for the mining of the lignite.

THE MORTIMER ENGINEERING CO., 210 Acton-lane, Harlesden, London, N.W.10, have been appointed sole agents in the United Kingdom, for RAVENSBURG face plate lathes, engine lathes, break lathes and slotting machines.

THE DOMINION RUBBER CO. LTD., established in London in 1905, have changed their name to U.S. RUBBER INTERNATIONAL (GREAT BRITAIN) LTD. The change in no way effects the structure or operation of the company.

NU-SWIFT LTD., fire-extinguisher manufacturers, Elland, Yorkshire, announce that their new London showrooms and offices, at 25 Piccadilly, W.1, are now open.

The formation of a United Kingdom subsidiary company of the SQUARE D COMPANY, of Detroit, U.S.A., has been announced. The new company, SQUARE D LTD., has its headquarters at 100 Aldersgate-street, London, E.C.1. The directors are MR. F. W. MAGIN, MR. F. H. ROBY and MR. J. F. MAGIN, of the parent company and MR. B. C. SPICER and MR. R. P. CHAMBERS of the United Kingdom.

Owing to the growing demand for industrial electronic controls, ELCONTROL LTD., 10 Wyndham-place, London, W.1, have taken a newly-built factory next door to their present site, which will give them three times the floor area and will provide room for much needed development.

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CONTRACTS

Power-Station Plant. Equipment for a large coal-fired steam power plant, at Huntley, some 50 miles south of Auckland, New Zealand, is to be supplied by firms in the United Kingdom. The plant comprises six boilers supplying steam to six turbo-alternators, each of 30,000 kW capacity. The boilers will be provided by BABCOCK AND WILCOX LTD., while the ENGLISH ELECTRIC CO. LTD., and the METROPOLITAN-VICKERS ELECTRICAL EXPORT CO. LTD., will each supply three of the turbo-alternator sets. The consulting engineers for the scheme are MESSRS. PREECE, CARDEW AND RIDER, and the consultants for the civil engineering work MESSRS. ALEXANDER GIBB AND PARTNERS.

Oil Tankers. A £12 million order for the building of a further seven tankers for the fleet of the Eagle Oil and Shipping Co. Ltd., 16 Finsbury-circus, London, E.C.2, has been placed with United Kingdom shipyards. Three of the ships will be of 18,000 tons deadweight capacity and four will be "super-tankers" of 32,000 tons deadweight capacity making an aggregate of 182,000 tons. The vessels will be steam-turbine propelled and delivery is expected between 1957 and 1959. CAMMELL LAIRD & CO. LTD., Birkenhead, and the FURNESS SHIPBUILDING CO. LTD., Billingham, Co. Durham, will each build two 32,000 ton and one 18,000 ton tankers and SMITH'S DOCK CO. LTD., Middlesbrough, will build one tanker of 18,000 tons.

Air Liners. Canadian Pacific Airlines have placed an order with the BRISTOL AEROPLANE CO. LTD. for three Bristol Britannia turbo-prop airliners to be delivered in 1957.

Electric Cable. A contract to the value of approximately 500,000 dols. has been awarded to ENFIELD CABLES LTD., Victoria House, Southampton-row, London, W.C.1, by the Hydro-Electric Power Commission of Ontario, Canada. The cables will be laid in Ottawa and will cross the Rideau Canal. Two and a half miles of 115 kV double circuit 80 MVA pipeline compression cables (conductor size 300 cm.) are to be laid by Enfield Cables' contract department in Canada. The installation is due to be commissioned on May 1, 1956.

Sea-Water Evaporating Plant. An order for two sea-water evaporating and distilling plants has been placed through Balfour, Williamson Merchant Shippers Ltd., of London, for the Lobitos Oilfield, Peru, with G. AND J. WEIR, LTD., Cathcart, Glasgow, S.4. They are for delivery in 1956 and 1957. The first plant will provide 270 tons of fresh water a day and the second will have an output of 500 tons a day. The plants will supply all the fresh-water requirements of the oil fields including that for domestic use.

Diesel Engines for Tractors. A Yugoslav export order worth nearly £1 million has been secured by F. PERKINS LTD., Peterborough. This firm has undertaken to supply agricultural-tractor Diesel engines to Industrija Motora and Industrija Traktora. The engines are to be installed in Ferguson tractors and Industrija Traktora have also negotiated a contract with the MASSEY-HARRIS-FERGUSON organisation. First deliveries of engines will commence in November and will be installed in these tractors at Coventry. The remainder are to be shipped direct to the Industrija Motora factory at Rakovica, near Belgrade. Ferguson tractors will be built in Yugoslavia fitted with three-cylinder P3 engines. A larger tractor fitted with the six-cylinder P6 engine is also to be built.

Book Reviews

MANAGEMENT ANALYSED

The Practice of Management. By PETER F. DRUCKER. *William Heinemann, Limited, 99 Great Russell-street, London, W.C.*1. (25*s*.)

Mr. Drucker, who, in his book *The End of Economic Man*, exposed the inadequacy of economic interpretations of the political horrors of the 1930's, has spent the last 20 years studying American business. His latest book is an ambitous attempt to write a philosophy of management, strictly defined as management of business enterprise; that is to say, of undertakings which are only justified by their economic results. It is a pity that a book which has so much to say that is wise should suffer from the common American fault of long-windedness and, in places, woolliness, so that many will be put off from reading it. In particular the sections which deal with current technological changes and with production problems are insufficiently informed and frequently naïve. This is perhaps not surprising in a writer who confuses a steam engine governor with a boiler safety valve, but it must cause doubts of his ability to interpret and draw conclusions from the large number of highly simplified case study examples around which his book is written.

The general thesis from which Mr. Drucker starts is that management's public responsibility as one of the leading groups in the community is relatively narrow: it is to make whatever is genuinely in the public good become the enterprise's self-interest. This restricts its responsibility to areas in which it can legitimately claim authority ; if it tries to extend it into wider social or political fields it invites opposition from other groups and, eventually, interference by the state. Assuming equality of opportunity and free enterprise as the basic social beliefs, management has the responsibility of keeping open the opportunity to rise from the bottom according to ability and performance and of developing a long-term investment policy to counteract the extremes of the business cycle. It must also develop policies that stabilise employment and will overcome the deep-seated hostility to profits by workers who object to having their own individual purposes and objectives subordinated to the impersonal objectives and laws of the enterprise.

It is by setting suitable and accepted objectives at all levels in the enterprise that management can best carry out this task. The economist's theory of business behaviour as the " maximisation of profits," while suitable for simple trading, is useless for this purpose, if only because profits are almost impossible to define in large-scale enterprise, part of whose objectives must be to remain in existence in ten, twenty or fifty years' time. The idea of the business executive as the personal delegate of the owner has given way to that of the manager whose authority is grounded in the objective responsibility of the job. Arbitrary orders have been replaced by performance standards based on objectives and measurements. The two basic functions of business for which objectives must be set are marketing and innovation, but the areas in which management objectives of performance and results are needed include market standing compared with market potential; innovation in products, manufacturing methods and services even where the technological changes are not spectacular; productivity as measured by " contributed value " ; the planning of the necessary physical and financial resources as far ahead as the nature of the business demands; and the determination of a profit level which is the minimum needed to yield the market rate for the capital required for plant replacement and expansion.

It is within such a framework of objectives that Mr. Drucker discusses the detailed aspects of management practice. He frequently arrives at conclusions which are likely to shock the traditional exponents of the art. He believes, for instance, in management by a team rather than by a chief executive, but a team of which each member has individual responsibility for decisions in defined areas. The requirements of skills, temperaments and kinds of work exceed any one man's capacity, with the result that he tends to surround himself with a staff of personal assistants without responsibility. This Mr. Drucker describes as " government by crony." An executive team makes easier the problem of succession, particularly important in view of the current erosion of the board of directors as a functioning organ of the enterprise. Mr. Drucker believes that the board cannot be the governing organ that the law considers it to be, but an organ of review, appraisal and appeal, and for these purposes it should not be composed chiefly of the working executives, but of members who have never served as full-time officers of the company.

The danger of the multiplication of management levels is best dealt with by decentralisation —federally (i.e., by product or region) if possible; functionally if necessary (e.g., on railways). In this way the old concept of the limited " span of control " can be replaced by a much larger " span of responsibility." The general purposes of the enterprise, its integrity and the morality of its management must be maintained by a code of practices.

The least satisfactory part of this book is that dealing with the management of the worker. Mr. Drucker recognises the unsatisfactory position of personnel administration to-day and the frustration of the students of human relations, but his own contribution, while supporting certain recently expressed views, does little to clear up the confusion. He rightly emphasises that there is no such thing as " labour " in the sense of human beings considered as a purely material, if not inanimate, resource. Nor is it sufficient for business to become a sort of welfare corporation providing workers' satisfaction by means external to the job. He sees the task as that of reversing the trend of early scientific management, which not only analysed jobs but also broke them up into their separate elements for performance by separate workers. The need is to maximise jobs, to allow workers to participate in developing methods and to set their own working targets. The enterprise must expect of the worker not the passive acceptance of a physical chore, but the active responsibility for the enterprise's results and, because this is a much bigger demand than merely a fair day's work for a fair day's pay, it is more likely of achievement. Man's capacity is largely determined by the demands made on him.

This is in contradiction to the old ideas of the personnel administrators, which assumed that people did not want to work, and of the more recent negative concepts of the human relations school which were more concerned with finding ways of " adjusting " the worker by psychological means so that he conformed to management's will. Recent research work has even cast doubts on the assumption that the happiest worker is necessarily the most efficient. There is a lot of fruitful thinking, as well as a lot of confused moralising, in these chapters, but they are unlikely to be of much immediate practical use to most managers. It is to be hoped that Mr. Drucker will devote the next few years to a more detailed study of the application of his ideas in particular cases. The resulting conclusions might well be of great value.

LAUNCHES AND TRIAL TRIPS

S.S. " JARAGUA."—Single-screw oil tanker, built by the Götaverken Shipyard, Gothenburg, Sweden, for A/S Kosmos (Managers: A/S Anders Jahre & Co.), Sandefjord, Norway. This is the yard's first turbine-driven merchant ship and is stated to be the largest vessel so far constructed in Scandinavia. Main dimensions: 663 ft. 4 in. overall by 86 ft. by 47 ft. 2 in.; deadweight capacity, 34,320 tons on a mean summer draught of 34 ft. 8 in. Steam turbines with double-reduction gearing, developing 9,800 s.h.p. at 115 r.p.m. in service, designed by Akt. de Lavals Angturbin, Stockholm, and constructed partly by de Lavals and partly by the shipbuilders. Steam supplied by two Babcock and Wilcox oil-fired boilers. Speed, 15 knots fully loaded. Delivered September 26.

M.S. " GEORGE LYRAS."—Single-screw oil tanker, built by Bartram and Sons, Ltd., Sunderland, for Marine Enterprises Ltd. (Managers: Lyras Brothers, Ltd., London, E.C.3). Largest vessel so far constructed by these shipbuilders, her gross tonnage being an advance of some 18 per cent. above that of any previous ship launched from their yard. Main dimensions: 525 ft. between perpendiculars by 67 ft. 9 in. by 38 ft.; deadweight capacity, 16,900 tons on a draught of 29 ft. 10 in.; gross tonnage, 11,588. N.E.M.-Doxford six-cylinder opposed-piston reversible oil engine, developing 6,800 b.h.p. at 119 r.p.m. in service, constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Wallsend-on-Tyne. Service speed, 13¾ knots. Delivered, September 26.

M.S. " BRANITA."—Single-screw oil tanker, built and engined by the Götaverken Shipyard, Gothenburg, Sweden, for the Rederi A/S Freikoll, Ludv. G. Braathen, Oslo, Norway. Main dimensions: 650 ft. overall by 82 ft. by 46 ft. 3 in.; deadweight capacity, about 30,200 tons on a draught of 34 ft. Götaverken ten-cylinder single-acting two-stroke Diesel engine, developing 9,860 b.h.p. at 112 r.p.m. Speed, 15 knots fully loaded. Launch, September 29.

M.S. " KAWERAU."—Single-screw cargo vessel, built and engined by Alexander Stephen and Sons, Ltd., Glasgow, for the New Zealand to Australia service of the Union Steam Ship Co. of New Zealand, Ltd., London, E.C.3, and Wellington, New Zealand. Main dimensions: 325 ft. by 50 ft. by 26 ft.; deadweight capacity, about 5,300 tons. Stephen-Sulzer six-cylinder Diesel engine, developing 2,410 b.h.p. at 128 r.p.m. in service. Delivered, September 29.

M.S. " FLAMINIAN."—Single-screw cargo vessel, built by Henry Robb, Ltd., Leith, for Ellerman Lines Ltd., London, E.C.3. Main dimensions: 325 ft. between perpendiculars by 52 ft. by 30 ft. to shelter deck; deadweight capacity, about 3,500 tons on a mean draught of 20 ft. 3 in. Clark-Sulzer eight-cylinder two-stroke Diesel engine, developing 3,350 b.h.p. at 133 r.p.m. in service, constructed by George Clark (1938), Ltd., Sunderland. Launch, October 4.

M.S. " KARMT."—Single-screw oil tanker, built by the Furness Shipbuilding Co., Ltd., Haverton Hill, County Durham, for Skibs A/S Corona (Managers: H. M. Wrangell & Co.), Haugesund, Norway. Second oil tanker constructed for these owners. Main dimensions: 525 ft. between perpendiculars by 71 ft. by 39 ft. 3 in.; deadweight capacity, about 18,190 tons on a summer draught of 30 ft. 6 in.; oil-tank capacity, about 17,000 tons. Hawthorn-Doxford six-cylinder single-acting two-stroke reversible oil engine, developing 6,600 b.h.p. at 115 r.p.m. in service, constructed by Hawthorn Leslie (Engineers), Ltd., Newcastle-upon-Tyne. Speed, 15 knots. Trial trip, October 6 and 7.

M.S. " SEDIA."—Twin-screw tug, built by Ferguson Brothers (Port-Glasgow), Ltd., Port-Glasgow, for the Shell Co. of Singapore, Ltd., Singapore. Main dimensions: 100 ft. by 28 ft. by 14 ft. When completed, the vessel will undertake the voyage to Singapore under her own power. Propelled by two uni-directional two-stroke Diesel engines developing 1,300 s.h.p. at 340 r.p.m., and driving the propellers through reverse-reduction gearboxes producing a corresponding propeller r.p.m. of 136. Engines constructed by Crossley Brothers Ltd., Openshaw, Manchester, and installed by the shipbuilders. Launch, October 7.

S.S. " HAMINEA."—Single-screw oil tanker, built by Smith's Dock Co., Ltd., South Bank-on-Tees, for Shell Tankers, Ltd. (Marine Managers for the Anglo-Saxon Petroleum Co., Ltd.), London, E.C.3. Main dimensions: 530 ft. between perpendiculars by 69 ft. 3 in. by 39 ft.; deadweight capacity, 18,050 tons on a draught of 29 ft. 8½ in. Double-reduction geared steam turbines and two Foster Wheeler oil-burning boilers, constructed by Hawthorn Leslie (Engineers), Ltd., Newcastle-upon-Tyne, and installed by the shipbuilders. Service speed, 14½ knots. Delivered, October 10.

BOOKS RECEIVED

Some of the books noticed here are selected for extended review in ENGINEERING.

Vibrations in Buildings. Building Research Station Digest No. 78. *H.M. Stationery Office, Kingsway, London, W.C.2.* (3*d.*)

Although vibrations as experienced in the United Kingdom rarely cause much damage to buildings, they can be inconvenient or even intolerable to people and may contribute towards dilapidation of buildings. The present knowledge on this subject, particularly the effects due to different causes and their extent and magnitude, are summarised in this paper, together with suggestions for reducing the effects by, for example, isolation of machines and buildings.

Thermodynamic Properties of Fluids and Other Data. By Y. R. MAYHEW and G. F. C. ROGERS. *Basil Blackwell, 49 Broad-street, Oxford.* (2*s.* 6*d.*)

The fluids included in this book of tables are water, steam, ammonia, Freon-12, and mercury. Values of k, ρ and c_p are also given for some other substances. British thermal units are used throughout.

Concrete Roads in Belgium and Western Germany, 1954: Their Structural Design and Performance. Road Research Technical Paper No. 35. Published for the Department of Scientific and Industrial Research by *H.M. Stationery Office, Kingsway, London, W.C.2.* (3*s.*) (See Weekly Survey in the issue of October 7.)

The Design of Bituminous Road Compositions. By DR. A. R. LEE. Technical Note No. 2. *The British Rubber Development Board, Market Buildings, Mark-lane, London, E.C.3.* (Gratis.)

The note provides a detailed account of test procedures for the design of bituminous road compositions, giving particular attention to the use of rubberised bitumen. Illustrated by a dozen or so photographs and diagrams the subject is treated under three headings: surface dressings, open-textured Macadam surfacings, and dense surfacings.

The following reports are obtainable from the British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking-road, Leatherhead, Surrey :—

Trends in Early Insulating Oil Specifications. By E. A. EVANS. No. E/T59. (4*s.* 6*d.*) A review of some early work done by the Insulating Oils Committee of the Association since 1921. The author was chairman of the Committee.

Effect of Arcing on the Air Flow through the Nozzle of a Gas Blast Circuit-Breaker (Summarising Report). By A. A. HUDSON. No. G/T296. (21*s.*) A summary of investigations into the influence of the arc upon the air flow in the nozzle electrode of an axial-flow air-blast circuit-breaker. The nature of the air flow during arcing from the arc chamber to the nozzle and thence to the atmosphere is discussed, and the conditions leading to a reversal of flow at the nozzle entry are considered.

Electrode Processes in Spark Discharges. By R. CRAIG. No. L/T287. (12*s.* 6*d.*) An investigation of the effect of different electrode materials on the voltage against gap length characteristics of six-second, 100 ampere rectangular-current pulse gap discharges in hydrogen, air and argon.

Plasma Oscillations and Energy Loss of Charged Particles in Solids. By H. FROHLICH and H. PELZER. No. L/T322. (3*s.*) The purpose of this report is to point out that there is a phenomenological connection between the possible frequencies of longitudinal electric waves and the optical constants. The theory of plasma oscillations is therefore a special case of the theory of absorption and dispersion. Furthermore, the energy loss of fast particles can be predicted from a knowledge of the optical constants, and if the latter are known it is possible to decide whether or not to expect energy loss in discrete steps.

Investigation of Deterioration of Moulded Carbon Resistors: First Report. By H. F. CHURCH and J. J. WALSH. No. Z/T92. (7*s.* 6*d.*) This report contains a brief description of the results obtained during the first twelve months of a research programme to investigate the deterioration of moulded carbon resistors. It covers a general study of the mechanism of conduction and the results of life tests on some 350 resistors. There is also a description of a resistor noise measuring set which it is hoped to use in later work

The Performance of Insulated Carbon-Resin Film Resistors. By F. G. RIVERS. No. Z/T95. (15*s.*) The results of investigations undertaken to discover the performance of Grade II fixed resistors of a particular make and type (in which the resistive element is a conductive varnish film on a glass tube embedded in a non-conductive moulding) are described. The studies included the effects of over-running on working temperature and performance, of operating at elevated temperatures without applied voltage and of making certain changes in the manufacturing technique. Temperature coefficient, noise, changes of noise level during life, changes of resistance on the shelf and "recovery" after prolonged loading were also examined.

Hydraulic Research in the United States, 1955. Edited by HELEN K. MIDDLETON. U.S. National Bureau of Standards Miscellaneous Publication 215. *The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A.* (1.25 dols.)

The information contained in this publication has been compiled from reports by the various hydraulic and hydrologic laboratories in the United States and Canada. Brief statements are given of the sponsors, purpose and nature of the research and, where available, record is given of the results so far obtained and of the reports published. In the case of each item, further information will be given by the laboratory concerned to *bona fide* inquirers.

Coal Mines in Canada. Prepared by the Mineral Resources Division, Mines Branch, Canadian Department of Mines and Technical Surveys. List 4-1. *Department of Mines and Technical Surveys, Ottawa, Canada.* (25 cents.)

This list gives operating data on coal producers in Canada. For the purpose of the present issue, coal producers are divided into two categories—active and inactive producers—at January 1, 1955. Final production figures for 1954 were not available at the time the report was prepared and such figures are therefore only preliminary estimates. Classification is first by area and then by operator, and total figures for all areas are given in separate tables.

Taschenbuch für Bauingenieure. Edited by PROF. DR.-ING. FERDINAND SCHLEICHER. In two volumes. *Springer-Verlag, Reichpietschufer 20, Berlin, W.35.* (56 D.M.)

These two volumes constitute the second edition of an extensive manual for constructional engineers. A number of writers contribute sections which combine to form a reference work on the particular aspects dealt with, for practical and instructional use by experienced engineers and students. The purpose is not to replace existing textbooks entirely, nor are features of comparatively limited interest to specialists included, but appropriate references to other sources of more detailed information are provided. In order to bring the subjects up to date, any developments during the last decade are included but, with a few exceptions, tables and full texts of relative German standard specifications are omitted so as to keep the work as concise as possible. There are 2,740 explanatory diagrams and drawings. The individual contributions are arranged progressively from mathematics, the mechanics of rigid bodies, the science of the strength of materials and the theory of elasticity, and statics, to materials and their properties, superstructures, constructions in wood, steel and concrete, the theory of bridge building, stability, and vibration. Continuing in the second volume, the subjects are: soil mechanics; earthworks; tunnel and gallery construction; foundations; traffic and its requirements; air transport and its requirements; railways; road planning and construction; hydromechanics; internal waterways and marine hydraulic works; dams and hydro-electric power plant; town planning; surveying; water supply and drainage; and machinery for the constructional engineer.

La Géométrie des Groupes Classiques. By JEAN DIEUDONNÉ. Part 5 of Ergebnisse der Mathematik und Ihrer Grenzgebiete. *Springer-Verlag, Reichpietschufer 20, Berlin, W.35.* (19.60 D.M.)

This book is part 5 of a series on mathematical results and their limitations published under the auspices of the "Zentralblatt für Mathematik." It covers the geometry of classical groups and the theories expounded are broadly an extension of those forming the object of part of "Groups of Linear Transformations" previously issued in this series. Among the linear transformation groups, only those called "classical" are considered and the questions dealt with in this connection arise from the "elementary" part of the theory of groups, gravitating essentially around the two notions of subgroup and homomorphism. No approach is made to those parts of the theory which involve more complex notions. There is an index of definitions and of the principal theorems and a bibliography which, however, does not claim to be complete for works brought out prior to the year 1935.

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Jointing, Valves and Level Indicators. RICHARD KLINGER LTD., Klingerit Works, Sidcup, Kent. "Master Catalogue" containing seven main sections dealing with jointing and packing materials; sleeve-packed cocks; level indicators for pressures up to 6,000 lb. per sq. in.; seatless piston valves up to 6 in. diameter; stream-line valves; and disc valves. Also servicing booklet for cocks, valves and indicators, leaflet on jointing compounds and pamphlet on surfacing materials.

A Group's Activities. THE DAVID BROWN COMPANIES, Meltham, Huddersfield. "Exempli Gratia"—a coloured illustrated booklet of 60 pages describing the activities of the David Brown organisation, ranging from gears to tractors and motor cars, with applications to all branches of industry. There are 17 companies in the group.

Industrial Stoneware. DOULTON & CO., LTD., Albert-embankment, London, S.E.1. Stoneware for chemical and industrial use. Tanks and storage vessels, outlets and cocks, pipe-lines and fittings, filters, grinding equipment and towers and containers of all sizes. General illustrated catalogue.

Humidity Recorder. CAMBRIDGE INSTRUMENT CO., LTD., 13, Grosvenor-place, London, S.W.1. Direct-reading, two-pen, temperature and humidity recorder, 20 to 100 deg. F. and 20 to 100 per cent. humidity. Other ranges and remote operation available. Leaflet.

Compressors and Vacuum Pumps. NORTHEY ROTARY COMPRESSORS LTD., Alder-road, Parkstone, Dorsetshire. "Oil Free" compressors and vacuum pumps with interlocking rotors; air or water-cooled, for pressures up to 45 lb. per sq. in. or vacuums of 29 in. Hg (single stage). Illustrated leaflets.

Industrial Radiography. INSPECTION EQUIPMENT, 19 Broad-court, Drury-lane, London, W.C.2. "Fedrex" X-ray equipment for industrial radiography. First number of a bulletin to be issued at regular intervals, describing this equipment and its operation.

Milling Cutters. FIRTH BROWN TOOLS LTD., Carlisle-street East, Sheffield 4. "Zeelock" serrated blade cutters with adjustable blades of high-speed steel. Sizes from 4 to 16 in. in diameter. Description list No. 199/2. (This corrects paragraph in our issue of October 7.)

Molybdenised Lubricants. ROCOL LTD., Ibex House, Minories, London, E.C.3. Lubricants containing molybdenum disulphide; properties, grades and uses. Also physical properties of MoS_2. Booklet with illustrations of test blocks.

Protection by Phosphating. THE PYRENE CO., LTD., Metal Finishing Division, Great West-road, Brentford, Middlesex. Unusual applications of phosphating process in preventing wear and corrosion. August/September issue of the "Bonderizer."

Lubricating Machine Tools. FLETCHER MILLER LTD., Alma Mills, Hyde, Cheshire. "Machine Tool Lubrication," describing different methods available for each type of tool and bearing. Includes chart of recommended grades. Booklet.

Lubrication with Molybdenum Disulphide. K. S. PAUL (MOLYBDENUM DISULPHIDE) LTD., Great Western Trading Estate, Park Royal-road, London, N.W.10. Field report B.R.3 and memorandum on the use of Molykote lubricants in a coal crusher.

Catalytic Oil-Gas Process. POWER GAS CORPORATION, LTD., Stockton-on-Tees. "Segas" process for producing gas from oils or tar. Illustrated description of process and applications.

Aluminium for Road Transport. THE ALUMINIUM UNION LTD., Adelphi, London, W.C.2. Use of aluminium in road vehicles as sheet and extruded section. Illustrated leaflet.

Air Compressors. HYMATIC ENGINEERING CO., LTD., Redditch, Worcestershire. High-pressure, diaphragm and rotary compressors and accessories. Illustrated folder HE. C631.

P.V.C. Fans. KEITH BLACKMAN LTD., Mill Mead-road, London, N.17. P.V.C. fans and lined ducting for handling corrosive fumes. Sizes up to 42 in. in diameter. Leaflet.

Calculator. CARBIC LTD., 54 Dundonald-road, London, S.W.9. The "Otis King" cylindrical calculator, equivalent to a 66 in. slide rule. Two models—one with logarithms. Leaflet.

Suds Pump. SALESCOPE, 32 Church-street, Leicester. Gear-type suds pump with capacities from 120 to 1,250 galls. per hour. Illustrated leaflet.

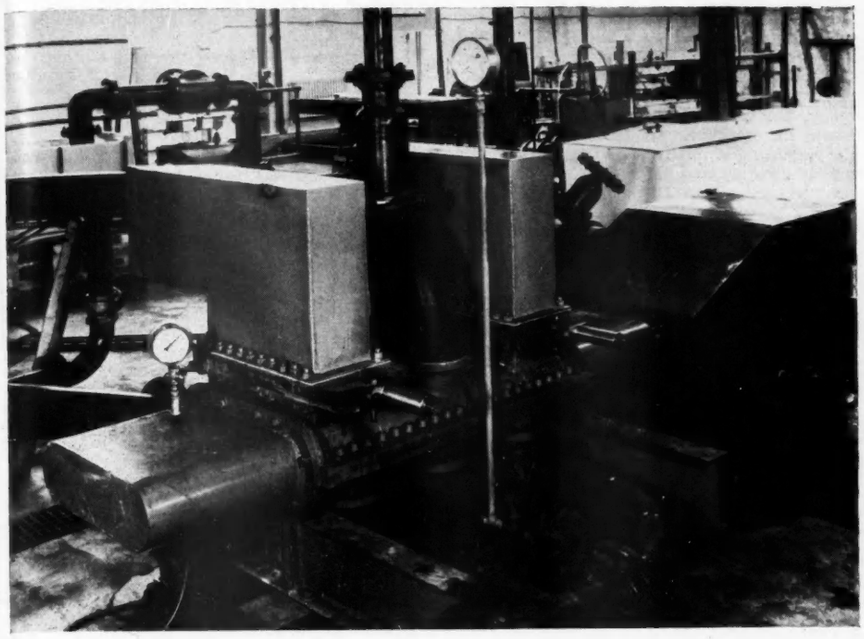


Fig. 1 Three-cylinder feeder for hydraulic transport of coal. The machine is undergoing wear and leakage tests before being installed at a colliery in the East Midlands.

HYDROMECHANICS RESEARCH

CURRENT INVESTIGATIONS OF THE B.H.R.A.

The British Hydromechanics Research Association was founded about eight years ago for the purpose of assisting its members by advice and research work in the technical problems they encounter in the industrial applications of fluid flow. Membership is open to all British firms likely to benefit from the work of the Association, either as manufacturers or users, and the organisation, which is non-profit making, is controlled and financed by its members, now numbering about 50, with the aid of a proportionate Government grant. Consulting engineers and senior academic workers are also admitted to associate membership. Since the Association's Research Laboratory was opened at Harlow, in Essex, in 1951, its technical activities have increased considerably, so that its annual income now exceeds £50,000.

The Laboratory at Harlow, which has a floor space of 14,000 sq. ft., is well equipped with plant, instruments and apparatus for dealing expeditiously with a wide range of fluid-flow problems and ample space is available for expansion. The work is in charge of the Director, Mr. L. E. Prosser, A.K.C., B.Sc., M.I.Mech.E., who has a research staff of six senior members, in addition to assistants and workshop personnel, making a total of 40 persons. To enable members and others interested to see something of the work now in progress at the laboratory, Open Days were arranged on October 5 and 6 and over 500 visitors were received. The exhibits, about 20 in number, can be classified under three headings, long-term basic research, basic research with a fairly definite application in view, and work of more immediate practical utility, but it will be readily understood that the divisions cannot be absolute in all cases.

HYDRAULIC TRANSPORT OF COAL

An interesting example of the third category is afforded by the work on the hydraulic transport of coal which the Association is carrying out on behalf of the National Coal Board. The work, which commenced with a theoretical investigation into the possibilities of the process, has now been extended into the engineering field and one of the exhibits was an experimental three-cylinder feeder designed and constructed in the Laboratory to inject 50 to 100 tons of coal per hour into a high-pressure water pipe in which it will be brought to the surface from a mine 500 ft. deep. The machine, illustrated in Fig. 1, is now undergoing wear and leakage tests in a closed circuit and when these have been completed satisfactorily it will be installed in a colliery in the East Midlands. It may be of interest to note that a similar machine, developed by the National Coal Board from a single-cylinder prototype designed by the Association, has been in operation for some time at Wood End Colliery, near Edinburgh. Considerable engineering development will, of course, be required before such systems can be made convenient and reliable, but their possible economic and other advantages are obvious.

In connection with the hydraulic transport of large solids, such as coal, in pipelines, experimental work has made it possible to estimate the pressures required with fair accuracy, but the conditions of flow inside the pipeline have not yet been satisfactorily explained and laboratory work is now being carried out to throw light on these. For this purpose, the 3 in. experimental coal-pumping plant has been reconstructed to enable long lengths of test pipe (100 ft.) to be laid out on the flat roof of the laboratory. The flow of coal is controlled by a rotary feeder and the concentration in the delivered mixture is measured by weighing under water the coal delivered in a given time. The concentration of coal in the pipe itself is determined by weighing a 37 ft. section of the pipeline on the roof. The results have shown that, except at high velocities, the pressure drop along the pipe is directly proportional to the concentration in the pipe irrespective of that of the delivered mixture.

Regarding the flow in pipelines of slurries containing very fine particles, it has been found that the flow is not greatly influenced by density, but as the velocity is reduced a stage is reached where the pressure loss ceases to correspond with that for water alone. Comparisons between tests on the pipe flow of a fly-ash slurry and its properties as determined in a rotating-cylinder viscometer have shown that the pressure losses of such materials flowing in a pipe can be closely related to the viscosity-shear rate properties of the slurry. The high viscosity of slurries sometimes extends the region of viscous flow up to quite high velocities. Because of the variation of viscosity with shearing rate the Poiseuille equation for viscous flow is not applicable and one taking account of the variation of viscosity across the pipe diameter must be used.

SEPARATING CONTAMINATING LIQUIDS

In addition to the transport of solid particles in a liquid flowing in a pipe, consideration has also been given to the separation of fluid mixtures. In normal pipe flow droplets of a contaminating liquid, such as carbon-tetrachloride in water, will not settle out owing to turbulence. By passing the flow through an expanded section filled with a large number of parallel tubes of small diameter the flow can be made laminar and the contaminant will settle out in the small separating tubes by gravity. Travelling slowly along the separating tubes the contaminating fluid can be collected from the ends. Factors affecting the efficiency of the apparatus, which is illustrated in Fig. 2, are the uniformity of the velocity distribution in the separating tubes, the persistence of turbulent conditions in the entry length of these tubes and the method of removing the settled drops of contaminant.

DESIGN OF SUMPS

Most engineers will be aware of the loss of

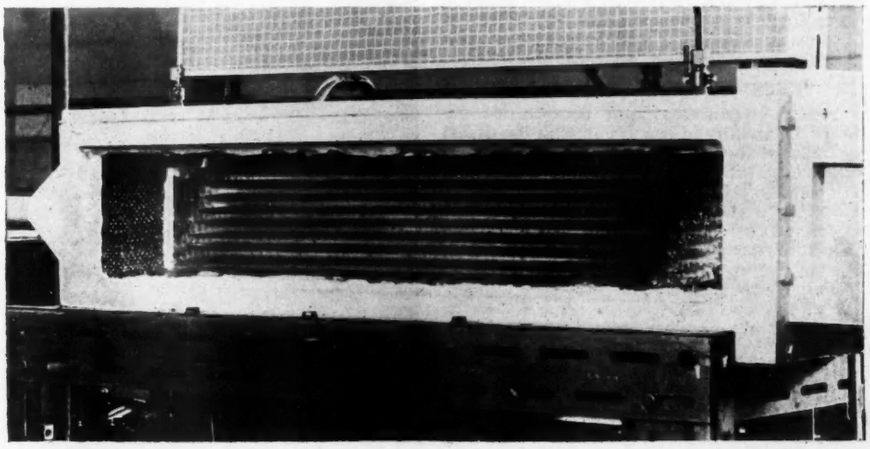


Fig. 2 Separation of fluid mixtures can be obtained if laminar flow can be induced. Equipment, consisting of numerous small-diameter pipes located in the main flow line, effects the required conditions.

Fig. 3 Bad sump design is often the cause of a vortex being formed in pumping installations. Experiments are in progress at the Laboratory to elucidate the contributing factors.

efficiency which may result in a pumping installation from faulty design of the sump and the Association has been studying the design of sumps in order to avoid the formation of air-entraining vortices, one of which is shown in Fig. 3. Experiments have shown that these arise from the asymmetrical flow of the water towards the suction inlet. Asymmetrical flow in the sump also leads to swirling in the suction pipe which, if severe, may affect the pump performance. One of the experiments, shown in Fig. 4, was arranged to illustrate this. It consisted of a vertical-spindle centrifugal pump mounted on a vertical transparent suction pipe drawing from a rectangular sump in which a vortex was forming. A small vane in the suction pipe could be seen to be rotating rapidly about a vertical axis in the same direction as the vortex in the sump; it was noticed that the direction of rotation of the vane was opposite to that of the pump impeller. Another exhibit was a model showing the poor flow from a badly designed sump for a land-drainage pumping installation. A drawing showing a well-designed sump for the same installation was annexed.

TESTS ON MODEL SPILLWAYS

Several investigations have been carried out in the Laboratory in connection with the design of spillways for hydro-electric and water-storage schemes. Three of the models used were shown in operation. One of these was a 1/200th scale model of a radial-gate spillway for a hydro-electric scheme and another was a 1/50th scale model of the side-channel weir and by-wash channel for the Hurst Reservoir of the Weir Wood Water Board. The prototype of this model was opened last month and it may be mentioned that the reservoir is used for the water supply of Crawley and of some other towns in Sussex. The third model exhibited was of the overflow weir, stilling pond and gauging weir for the Avon Dam to a scale of 1/60th.

TESTS ON CENTRIFUGAL PUMPS

Long-term basic research on centrifugal pumps is being carried out in the Laboratory and some examples to illustrate the work were included among the exhibits. One which may be mentioned showed the air-flow testing of a rotating impeller discharging freely into the atmosphere, the suction side being throttled. The relative velocity has been measured with hot-wire anemometers at several positions across a vane passage inside the impeller. At some distance within the impeller the relative flow angle is approximately constant and the highest velocity occurs near the suction face of a vane, although impellers previously tested in the Laboratory have not shown this similarity with the theoretical flow pattern. Towards the periphery of the impeller, however, the velocity near the suction face of a vane diminishes and marked changes in flow direction occur. Near the maximum efficiency point the head measured on this impeller by Pitot tubes, was about 6·5 per cent. higher than the delivery head of the impeller when in a volute casing, but at higher deliveries the difference was much greater.

Air-flow tests are also being made on a commercial 6 in. pump to provide information on the total head emerging from the impeller in its volute casing and to compare this with the head generated by the same impeller when discharging freely without a volute casing. The mixing process by which the velocity emerging from the impeller diminishes to the mean velocity in the volute and the energy losses in the volute and delivery branch are also being studied in these experiments.

To supplement the information obtained from air testing, apparatus, illustrated in Fig. 5, has been constructed to enable a pump impeller that is made of transparent material to be rotated in a horizontal plane in a large cylindrical water tank having transparent windows at the top and bottom. To render the flow visible small solid white spheres, made from a mixture of wax and lead stearate of unit specific gravity, are added to the water and the movements of these spheres through the impeller passages are recorded photographically. In this way the absolute and relative velocities can be determined.

A series of tests is now being carried out to determine the hydraulic friction of flexible hoses. In flexible metallic tubing the internal roughness is due, of course, to a helical groove of small pitch and this appears to cause some divergence from the theoretical loss in the laminar-flow region. Other work, which can be referred to only briefly, includes static tests on disc valves

Fig. 5 Flow in centrifugal pumps is being studied with the aid of transparent impellers, tanks with windows, and stream markers.

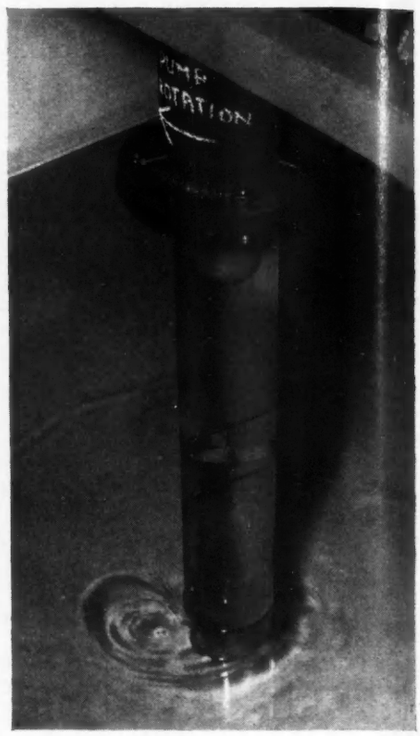


Fig. 4 The rotary motion of a vortex in a sump will continue up the suction pipe, as is shown by the rotary vane fitted in this transparent suction pipe.

for reciprocating pumps, the design of drifts for mine-ventilating fans, the processes involved in the sealing of rotary and reciprocating shafts and the testing of various conventional types of seals, and the flow of oil through small orifices at high pressures.

HYDRAULIC LOCK

The last-mentioned work is of importance in the design of hydraulically-operated servo-controls and other high-pressure oil systems for which a knowledge of the flow in small valve ports is required. Tests have been made on the coefficient of discharge of orifices at low pressures and varying Reynolds number. A new rig has been built recently to operate at pressures up to 10,000 lb. per square inch, to study the effects of compressibility and give results applicable to higher pressures than hitherto.

The locking in hydraulic control valves between the cylinder bore and the piston lands can be caused by tapered clearances and for pressures up to about 1,000 lb. per square inch the locking force is proportional to the pressure. Tests at pressures up to 10,000 lb. per square inch, however, are now being carried out and in this range the distortion of the piston and cylinder can be of the same order of magnitude as the original clearances; the viscosity of the oil, moreover, can increase to several times its value at atmospheric pressure. Tests have shown, however, that the locking force does not always increase with the pressure; in some cases a point has been reached at which further increase in pressure causes a reduction in the locking force until the piston becomes quite free. Convergent clearances between the piston and cylinder have the effect of centralising the former so that locking does not occur.

INFORMATION SERVICE

Finally we may mention that an important part of the Association's work is to give advice to members on their day-to-day problems and for this purpose an efficient information service is maintained. Examples of some of the problems dealt with, sometimes requiring special investigations, were shown.

THE USE AND DISPOSAL OF RADIOACTIVE MATERIALS

A REVIEW OF PAPERS PRESENTED AT GENEVA

By J. L. Putman, M.A., F.INST.P.*

Although the main preoccupation of the Geneva Conference was in the development of nuclear power, it was a tribute to the services already given by radioactive isotopes in medicine, agriculture and all branches of industry that about one third of the sessions was devoted to the discussion of this aspect of nuclear science. It is fair to suppose that the papers presented were representative of the most recently published information on the subject throughout the world, and we are therefore printing the following article in which papers concerned particularly with the application of radioactive isotopes to industrial research and practice are reviewed. Three United Kingdom papers on the industrial use of radioisotopes have already been published in ENGINEERING *(September 2, page 292, 1955). In the present article the disposal of radioactive wastes is also covered; the official reference figures of Conference papers are given in brackets.*

GENERAL PAPERS

In a general session of the Conference devoted to "The Use of Radioactive Isotopes," notable papers were presented by Dr. H. Seligman (U.K.), Dr. P. C. Aebersold (U.S.A.), and Dr. J. Guéron (France). Dr. Seligman's paper (P395) has been reported in ENGINEERING. In his paper (P308), Dr. Aebersold discussed "The Importance of Isotopes in Technology and Industry." He drew attention to the rapid growth in the use of radioisotopes as tracers for the study and control of chemical processes and as radiation sources for gamma radiography and for non-contacting thickness gauges. The potential uses of large radioactive sources for such purposes as the sterilisation of food or drugs were indicated, and also their possibilities for inducing chemical reactions in polymers to produce new plastics with desirable properties. In addition Dr. Aebersold briefly referred to the use of strontium 90, caesium 137, polonium 210 and tritium (isotope of hydrogen of mass 3) incorporated in special phosphors to provide luminous material, and said that beta-emitters had been found preferable to the more orthodox alpha-emitters for this purpose because they caused less damage to the phosphors.

In summing up the savings effected by the use of radioisotopes in American industries, Dr. Aebersold said that about 100 million dollars were now being saved annually by these techniques, particularly by the use of gamma radiography (by 400 U.S. firms), by radioactive thickness gauges, and by radioactive techniques in oilfield and refinery control.

TRACING LEAKS UNDERGROUND

Dr. J. Guéron, (P331) outlining recent applications of radioisotopes in France mentioned increasing use in non-destructive testing. He described how radioactive methyl bromide has been used to find gas leaks in pressurised electric cables underground and said that radioactive tracers had also been employed successfully to discover local water seepage on the site of a dam to be set up by l'Electricité de France. Neutron scattering had been used to find the hydrogen content (associated with water content) of soil. Detection by the activation of indium foils permitted concentration on epithermal neutrons and made the measurements less dependent upon soil contaminants which might absorb slow neutrons.

Radioactive methods of borehole logging included neutron and gamma-ray scattering methods, and a comparison of logs had been used for the identification of coal and carbon deposits. Chromium 51 had been used successfully as a tracer for following sand movements under tempest conditions in the Mediterranean. In private discussions with the French scientists responsible, it was agreed that scandium 46 in glass as used in British experiments was probably a more convenient tracer.

Following a discussion of these papers, and the presentation of papers on medical and agricultural uses of radioisotopes, the subject of waste disposal was treated.

DISPOSAL OF REACTOR WASTES

Dr. E. Glueckauf (U.K.) proposed (P398) three alternative methods for the long-term safe disposal of fission products from power reactors. Permanent storage of solutions in cooled underground tanks, or immediate disposal of concentrated solutions in remote, uninhabited areas were methods involving the least expenditure; but the chemical separation of strontium and caesium from bulk fission products on specially treated clays might well prove to be the most economical, since the remaining radioactive fission products were relatively short-lived and their disposal at sea or underground would then be safe after a relatively short storage period. Concentrated strontium 90 and caesium 137 sources thus produced might be used industrially, helping to pay for the cost of chemical separation. Valuable materials such as ruthenium, rhodium, palladium, americium and technetium might also be recovered in appreciably inactive form from aged bulk solutions.

Dr. A. Wolman (U.S.A.) presented a paper (P310) with Dr. A. E. Gorman on "The Management and Disposal of Radioactive Wastes," in which he also advocated the recovery of caesium 137 and strontium 90 for industrial use as easing the problem of storage.

DETERMINING MINUTE IMPURITIES

When the Conference had divided into its three specialist sections (physics and reactors, chemistry and metallurgy, and radioactive isotopes) it was not until after sessions on biological and medical topics that the industrial uses of isotopes were again discussed. A part of the session on "Radioactive Isotopes in Research" was devoted to radioactivation analysis and included papers by Professor V. V. Jakovlev (U.S.S.R.), who showed how it was used for the quantitative determination of impurities in high-purity metals, and by Mr. A. A. Smales (U.K.), who discussed "Recent Advances in Radioactivation Analysis." Professor Jakovlev's paper (P632), presented by Dr. Vinogradov, dealt mainly with the determination of rare-earth impurities by thermal neutron irradiation. Experiments had been made with neutrons of well-defined energies to analyse for nuclides with strong resonance absorption, such as iridium and indium. This reduced the background due to unwanted activities and increased the sensitivity of the method.

Mr. Smales said that the technique of radioactivation analysis was now well established as an analytical tool. He outlined the method by which minute quantities of some substances could be determined by measuring the radiations they emitted after neutron irradiation in a pile. He listed (in his written paper, P770) 61 elements which could be determined in quantities from 1 microgram (for bismuth, calcium, iron, sulphur and silicon) to a millionth of a microgram (for europium and dysprosium) after irradiation in an atomic pile.

The value of the scintillation counter used as a gamma-ray spectrometer for the identification and measurement of those isotopes which emit gamma-rays was underlined. This method of measurement was especially valuable in the activation analysis of alloys without chemical separation, although when the greatest sensitivity was required, partial chemical separation was used in addition. Recent determinations of industrial importance included that of calcium in iron at the part per million level, sodium in lithium down to 0·02 parts per million, and such impurities as arsenic and copper (to 1 part in 10^{10}) in silicon for use in semiconductors.

METALLURGICAL RESEARCH

The session ended with a discussion of the use of isotopes for research in metallurgy. Professor G. V. Kurdyumov (U.S.S.R.) presented a paper (P702) on the investigation of diffusion and atomic interaction in alloys. He explained that the mobility of the solvent atoms in an alloy played a major part in determining its behaviour under stress at high temperatures. Self-diffusion in a pure metal could be studied by making a part of the sample radioactive, so that the movements of radioactive atoms through atoms of the same element could be traced by means of their radiations. This technique had been used for a number of years in pure metals. Professor Kurdyumov showed its development for the study of ferrous and non-ferrous alloys.

Considerable effort has been directed to research in pure and applied metallurgy in the U.S.S.R., to judge by the emphasis placed upon this subject in papers at the Conference and in the Russian exhibition. Two further papers (P707 and P713) on allied subjects were presented by Professor A. M. Samarin (U.S.S.R.).

IRON AND STEEL

The first, by Professor Samarin himself, described "The Use of Artificially Radioactive Isotopes in the Study of Production Processes of Steel and Iron." He reported that using phosphorus 32 and sulphur 35, studies had been made of the kinetics of dephosphorisation and desulphurisation of steel. It was interesting to note that when radioactive phosphorus was introduced at the bottom of a 30 ton open-hearth furnace during a period of fast boiling, the phosphorus was in equilibrium distribution between metal and slag after 30 to 40 minutes. Radioactive calcium (Ca 45) had been used in labelling the refractory lining of furnaces and the lining of ladles to determine the origin of non-metallic inclusions in steel. The erosion of ladle brick was found to account for as much as 18 per cent. of these inclusions, but could be lowered by the use of high alumina brick as the ladle lining.

Some interesting research into processes of steel crystallisation was made by adding radioactive indicators to a cooling ingot at various successive stages of cooling. When the ingot was cold, templates were cut and applied to photographic films. By this means, auto-radiographs were obtained showing the shape and structure of solidification zones. Much of this research had been made with commercial ingots weighing up to 10 tons.

WEAR OF MACHINE PARTS

The second paper presented by Professor Samarin was by Dr. B. D. Grozin (Ukraine S.S.R.) and concerned "The Use of Radioactive Isotopes in the Study of Wear of Engine Parts." Surfaces were made radioactive by electrodeposition, by direct introduction of radioactive material in casting, by the use of radioactive inserts, or by direct irradiation of whole engine parts. Radioactive wear particles were either measured in samples taken from the lubricating oil or in the continuously circulating oil. Special filters made of felt were alternatively used to collect wear particles. The advantages of these methods, in high sensitivity (down to 10^{-8} gm.) and convenience of measurement without dismantling test engines, were stressed, and their use was described for the testing of various engine parts and the investigation of anti-wear additives in lubricating oils.

It may be noted that most of the techniques described in the last two papers had also been

* Isotope Division of the Atomic Energy Research, Establishment, Harwell.

developed elsewhere and have certainly been used in the U.K. and the U.S.A. for some years, but the impression was given that the techniques, once developed are very rapidly employed in industrial work on a large scale. The same impression was gained in a paper (P704) by Dr. G. G. Jordan, V. B. Brodsky and B. S. Sotskov (U.S.S.R.), presented by Professor S. T. Nazarov on the "Application of Radioisotopes to the Control of Technological Processes." In this paper, radioactive thickness gauges of the transmission and back-scattering types were described, together with standard types of liquid-level gauge, again with particular emphasis upon their uses in steel production. An instrument which elicited some interested comment was a "defectoscope" by which welded seams were continuously inspected with a gamma-ray source and scintillation counter. Manometers, relying on the absorption of alpha-particles in gases, were described, which appear to be very similar to an instrument now being developed by a U.K. industrial firm.

Two U.K. papers (P463 and P462) presented by Mr. J. L. Putman on "Thickness Gauges and Allied Instruments" and by Mr. J. L. Putman and Mr. S. Jefferson on "Leakage and Hydraulic Measurements" have already been reported in this journal.

SULPHUR CONTENT OF FUEL BY X-RAYS

A paper (P 164) on the "Versatility of Radiation Applications Involving Penetration or Reflection," by Dr. C. E. Crompton (U.S.A.) was presented by Dr. P. Aebersold (U.S.A.). This paper gave a fairly comprehensive review of current types of beta- and gamma-radiation thickness gauges and level detectors. The advantages of automatic over manual control were stressed, and backed by experimental evidence of the uniformity of products using both methods of control. Of particular interest was the use of *bremsstrahlung* (secondary X-radiations) produced by a strong source of beta particles (Sr 90 + Y 90) for measurements of silt density under water. The advantages of these intermediate energy radiations was shown in their preferential absorption by the silt (of higher atomic number) rather than by water.

The use of X-rays from the iron isotope (Fe 55) for determining the sulphur content of liquid fuels was also described. Although published before, this technique deserves special mention. The X-rays are absorbed many times more heavily by sulphur than by the normal carbon and hydrogen constituents of the fuels and very sensitive detection of small sulphur contamination is obtained.

COKE DEPOSITS AND CORROSION

Dr. S. E. Eaton's (U.S.A.) review (P146) of "Radioisotopes in Industrial Research" illustrated the versatility of isotope techniques in various other fields. His examples of isotope applications included some well established methods such as the use of tracers to check industrial mixing experiments and the measurement of wear in engine parts, lathe tools and such surface finishes as paint and floor wax. Some less generally known applications included: the use of sulphur 35 for studying the action of ammonium thiosulphate as a brightener in silver plating baths; the use of carbon 14 labelled hydrocarbons to study the origin of coke deposits on catalyst beads in the catalytic cracking of petroleum, an investigation of the role of carbon disulphide in the inhibition of metallic corrosion, and the use of potassium, sodium and barium isotopes to determine hold-up times, mixing and channelling properties of the constituents in glass-making.

Dr. P. Leveque (France) with M. P.Martinelli and M. R.Chauvin described "Studies and Industrial Applications of *Bremsstrahlung* from the Beta Particles of Yttrium 90." (P383). In the *bremsstrahlung* source similar to the one developed simultaneously in the U.S.A., it was pointed out that secondary X-radiations or *bremsstrahlung* were generated by the impact of beta particles from strontium 90 and yttrium 90 upon targets of lead and other materials. Both a continuous X-ray spectrum and X-rays characteristic of the target material were evolved. The sources had been used for radiography and were specially suitable where low energy and long half-life were required. Analysis of mixtures is possible by observation of their characteristic X-radiations on irradiation with beta particles. An ingenious thickness gauge was also described in which the thickness of coating of a heavy element on a light one could be assessed by virtue of its characteristic X-radiations. Gold coatings on copper with thicknesses from 0 to 120 μ could be measured and an accuracy of about 3 per cent. was claimed.

POLYMERISATION BY RADIATION

The final isotope session was concerned with the utilisation of fission products which are likely to become available in quantities of thousands of curies as by-products of nuclear power, and dealt in particular with the uses of high radiation fluxes.

Two papers (P168 and P465) were presented on the subject of radiation-induced polymerisation. Dr. B. G. Bray (U.S.A.) reporting with Mr. L. C. Anderson and Mr. J. J. Martin on "The Effect of Gamma Radiation on some Chemical Reactions of Possible Industrial Importance," gave data on the radiation-induced polymerisation of ethylene and on the chlorination of aromatic compounds. Cost estimations indicated that radiation-induced reactions would probably become an economic proposition if the cost of fission products were not unduly high.

Dr. A. Charlesby (U.K.) (P465), in "Recent Developments in the Irradiation of Long Chain Polymers" endorsed the impression that the study of radiation effects were still in a very early stage. He discussed some of the known reactions of long-chain polymers to irradiation, such as "cross-linking" and the formation of very large molecules. He also discussed the inhibitory action of certain additives and advocated a study of the role of oxygen in the radiation processes. Some new desirable properties had already been induced in irradiated plastics, notably improved qualities in polythene. It is likely that further research will lead to more new plastics of engineering importance.

DUPLICATION OF RESEARCH

It has been possible to deal only briefly with the wealth of information presented at Geneva. Two facts emerged. First, disclosures of really new techniques in the direct uses of isotopes were rare. The international conference at Oxford last year and the efforts in many laboratories had already yielded the more obvious applications.

Secondly, the simultaneous development of almost identical techniques by different laboratories was very striking. While such a state of affairs is healthy in pure research and adds conviction to the findings, it tends to be wasteful of effort in applied research. Closer international co-operation and quicker publication in these fields could avert much duplication of effort.

The readiness of British industry to employ the new techniques now available leaves something to be desired. In the face of competition, particularly from the U.S.A. and the U.S.S.R., where radioactive techniques are evidently being adopted rapidly, it is to be hoped that we shall no longer hesitate to accept the advantages of proven radioactive methods.

SOVIET NUCLEAR EQUIPMENT

Use and Investigation of Isotopes

Editor's Note: Equipment made in Western countries for the study or application of radioactive isotopes will already be familiar; it may, however, be interesting to compare it with similar apparatus developed in the U.S.S.R. Fig. 1 shows a Soviet mass spectrometer for isotopic analysis in the mass-number range 1 to 225. It is suitable for studies of both gaseous and solid samples, and employs a mass scale for indicating mass numbers by fixed lines of mass spectra. It is used to investigate the isotopic composition of both stable and, in some cases, radioactive preparations. Accuracy of determination of isotope content with abundance of not less than 5 per cent. is $\pm$ 0·5 per cent. by visual examination of masses and $\pm$ 1 per cent. with spectra recording. The sensitivity of the instrument is such as to permit determination of isotope content with abundance 0·01 per cent.; discretion is 1/750. The panel of the mass spectrometer can be seen in Fig. 2. A thickness control unit used in Russian factories appears in Fig. 3. It employs beta particles to give a continuous record of thickness of strip material at high speed. The application of radioisotopes to industrial radiography in the Soviet Union is illustrated by the equipment in Fig. 4. This unit is designed for industrial gamma-defectoscopy under stationary and workshop conditions. The gamma-ray source is cobalt 60 (50 gm. equivalents of radium). Similar British equipment was described in the articles on pages 90, 115 and 431 of the current volume.

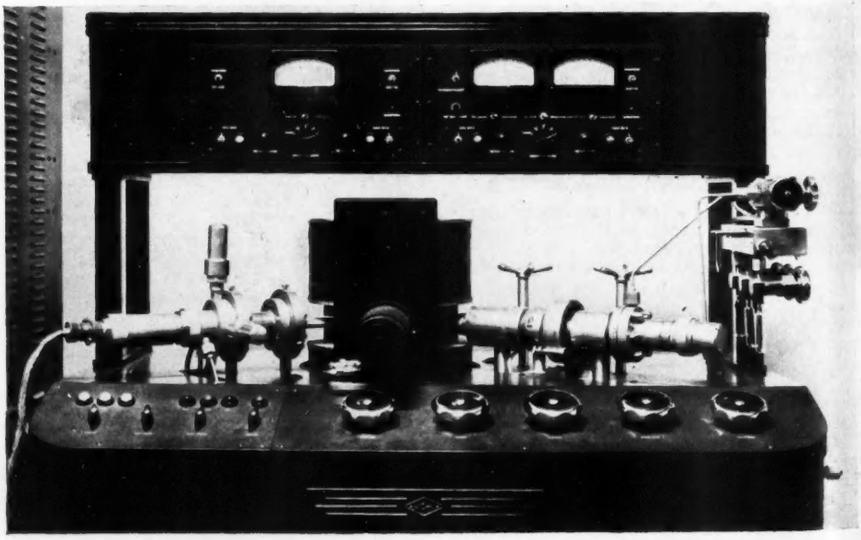


Fig. 1 Nuclear devices of many kinds are already familiar in Western countries but little is known of the corresponding Soviet equipment. This Russian mass spectrometer is designed for isotopic analysis in the mass-number range 1 to 225. (See note "Soviet Nuclear Equipment" above.)

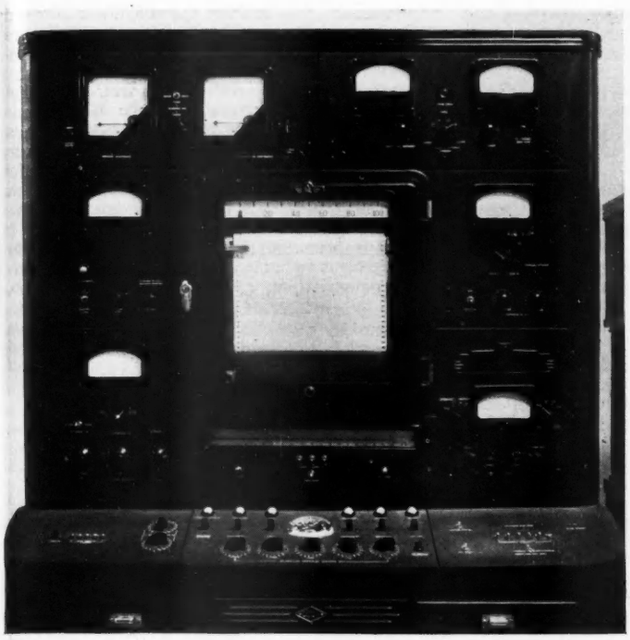


Fig. 2 Control panel of mass spectrometer shown in Fig. 1. The instrument is suitable for studies of both gaseous and solid samples and its accuracy in determining isotope content, with an abundance ratio of not less than 5 per cent., is ± 0·5 per cent.

Fig. 3. Thickness control unit used in Russian factories. Employing beta particles, it gives a continuous record of the thickness of strip material at high speed.

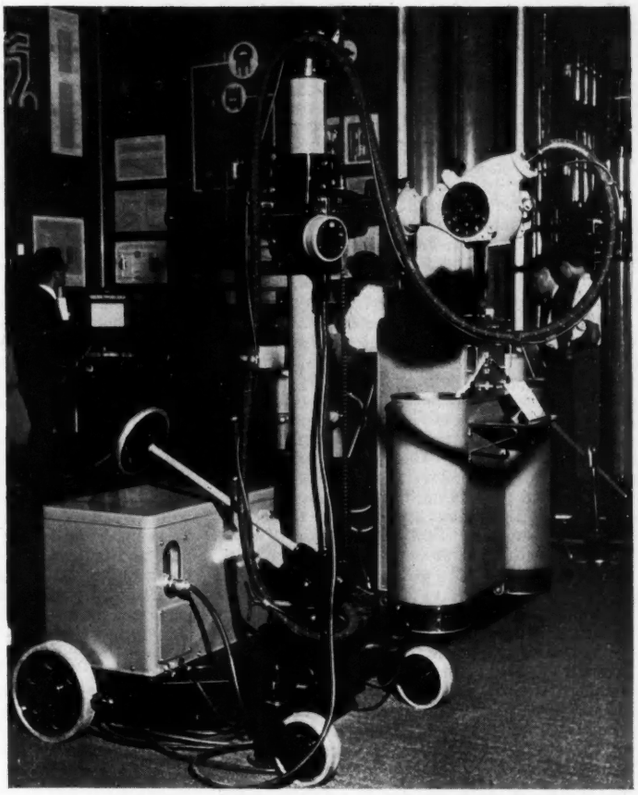


Fig. 4 Industrial radiography apparatus developed in the U.S.S.R. It is designed for gamma-ray checks under stationary and workshop conditions with cobalt 60 as gamma-ray source.

(These four illustrations are described in the note "Soviet Nuclear Equipment" on the facing page.)

SIDE-MOUNTING CRANE FOR TRACTOR

County Commercial Cars (Sales), Limited, Albert-street, Fleet, Hampshire, have developed a crane jib and winch for mounting on the side of a caterpillar tractor. The equipment was designed primarily for pipe-laying operations, to allow the tractor to move alongside the pipe trench. The tractor used is the County Crawler Mark III, which has a Fordson Major power unit and is fitted with wide tracks. In this combination the crane can lift 5 tons at 4 ft. or 2 tons at 10 ft. Automatic brakes are fitted to prevent accidental dropping of boom or load.

POWER FROM NUCLEAR FUSION

Intensified Research Programme Begun in U.S.A.

The chairman of the United States Atomic Energy Commission, Admiral Lewis L. Strauss recently announced that the commission had intensified its research on the problem of controlling the fusion or hydrogen-bomb reaction for power-production purposes. Admiral Strauss said that if these studies proved successful, it should be possible to produce enough energy to last mankind indefinitely at many times the present rate of usage. Whether or not it would be possible to harness this process would be known, he guessed, within 20 years, but in spite of the gigantic problems involved, he was optimistic.

The task of controlling the hydrogen reaction, he continued, had now achieved the status of a "major project." It was being conducted at Princeton University, the University of California, New York University, Los Alamos (New Mexico), Livermore (California) and Oakridge (Tennessee), but although it had been started in 1946 it was not until 1951 that it assumed important dimensions. He admitted, however, that it might be many years before an operating thermo-nuclear machine could be developed. The problem was fundamentally that of heating an appropriate nuclear material such as deuterium to a temperature of several hundred million degrees Fahrenheit and of confining it somehow at that temperature for a sufficient length of time to allow an appreciable proportion of the nuclei to fuse together, with consequent release of energy in the form of energetic neutrons and charged particles.

Professor L. Spitzer of Princeton University explained on the same occasion that thermo-nuclear burning occurred most readily with deuterium, which was present in water in small quantities. However, although only one deuterium nucleus occurred for every 6,400 nuclei of ordinary hydrogen, the total reserves of energy from this source contained in the world's oceans was enormous. But to use this energy it would be necessary to contain, within relatively cool walls, gas at a temperature now only reached at the centre of an atomic explosion or in the sun; it would also be necessary to control the thermo-nuclear reaction when it occurred; and, finally, some method of extracting the heat and using it to generate electricity would have to be discovered. There is, however, one advantage of the fusion reaction; as Admiral Strauss pointed out, danger from radiation is far less than in the fission process.

The Institution of Naval Architects Autumn Meeting (continued from page 565)

FRICTIONAL DRAG

SHIPS' HULLS RELATED TO PIPES AND PLATES

At the second technical session of the Autumn Meeting of the Institution of Naval Architects, held in the afternoon of September 20, only one paper was presented, this being on "Frictional Drag of Smooth and Rough Ship Forms," by Ir. A. J. W. Lap, of the Netherlands Ship Model Basin at Wageningen, Holland. The chair was again taken by Mr. R. B. Shepheard, C.B.E., B.Sc.

FRICTIONAL DRAG OF SHIP FORMS

Mr. Lap's paper described a new method of approximation to establish a relation between the resistance coefficients of pipes and of rectangular flat plates. The only method, the author premised, of deriving resistance formulae for turbulent flow along flat plates more or less theoretically was by starting from the theoretical formulae for pipe flow. His paper began, therefore, with an examination of these formulae (including those of von Karman, Prandtl, Telfer, Nikuradse, etc.) and of their applicability to the boundary layer of a flat plate. The method based on the relationship thus established proved to be in fair agreement with Schultz-Grunow's measurements of local frictional resistance. The coefficients for total frictional resistance as derived, with the aid of the theoretical formulae, from the local frictional resistance coefficients, and those derived from resistance experiments with flat plates, also showed an agreement which the author considered to be "highly satisfactory." As was shown in the paper, however, it was not satisfactory to apply plate-friction coefficients to ship forms, and a new method was indicated for calculating their frictional resistance coefficients.

It appeared, the author stated, that the frictional resistance coefficients of pipes, of plates (local and total) and of ship forms could be represented by the general formula

$$\frac{\kappa\sqrt{2}}{\sqrt{\zeta}} = \text{Log}\,\frac{\text{Re}\sqrt{\zeta}}{A_n} + \text{C}$$

where κ was the universal constant, with a value of 0·4144; Re was the Reynolds number, and C a constant; ζ was the total frictional resistance coefficient; and log A_0, for pipes, had a value of 1·000, log A_1 (local frictional resistance coefficients of flat plates) a value of 1·556, log A_2 (total frictional resistance coefficients of flat plates) a value of 1·980, and log A_3 (for ship forms) a value between 2·10 and 2·50. Values which frequently occurred for ship forms were log A_3 = 2·35 to 2·40. The use of the new resistance coefficients became very simple, Mr. Lap claimed, if they were given in a table of

$$\zeta = f\left(\log\frac{\text{Re}}{A_n}\right) = f(\log \text{Re} - \log A_n).$$

Mr. K. C. Barnaby, O.B.E., B.Sc., who opened the discussion, observed that during the first half of the 80 years which had elapsed since the classic experiments of Froude, the only alternative to his method was that due to the Dutch naval architect, Tideman. During the second half of that period there had been such a plethora of friction lines that he hardly knew whether to welcome a new method or to deprecate it as adding to the confusion. Mr. Lap's paper, however, was one to be welcomed as likely to help in the quest for the ultimate goal, a universally accepted three-dimensional friction line. It was pleasant to note that this new alternative to Froude also came from the Netherlands.

It was difficult to quarrel with the author's formula for the frictional resistance coefficients on the score of hydrodynamic correctness. The constants, however, were more debatable, and unless they received international acceptance the formula was of limited value. It would then serve only as a guide to the extrapolation from small flat or shipshape forms up to full-size hull surfaces. In an attempt to reduce the magnitude of that extrapolation, some experimenters used long pontoons and others resorted to wind tunnels. Both methods were open to criticism. The pontoons involved length/breadth ratios that were far outside all normal ship practice. Wind tunnels employed a fluid that, at normal pressures, had 13 times the kinematic viscosity of water. That must surely indicate a very different boundary-layer structure in the way of plate edges and in full afterbodies. It seemed preferable to rely on normal plate experiments extrapolated by such a formula as proposed by the author. In its present form, that formula was not explicit. As with the Schoenherr line, it would be necessary to have either tabulated values or a substitute formula that was sufficiently accurate. The former were undesirable as they had to be always on hand before frictional resistance could be calculated. They were also apt to convey an entirely erroneous idea of their accuracy when carried to more than three significant figures.

RAPID CALCULATION

All the more authoritative friction formulae gave lines that could be expressed as

$$\frac{1}{\sqrt{C_f}} = x\,(\log \text{Re} - \log \text{A}) + \text{C}.$$

Such a form was very easy to use, and he asked whether the author could not provide a substitute formula of that type, with constants modified to avoid the repetition of $\sqrt{2}$ and the use of hyperbolic logarithms. He had often thought that the more learned pundits did not always realise the value of time to a naval architect, who often had to produce a reasonably close power estimate within a few minutes, and to fix the leading particulars of a new design in a few hours. If that could not be done, short-period tendering and quick building became impossible. The situation was very different from that with aircraft, with which, apparently, the first three years might be spent in intricate calculations and the production of a prototype, and the next three years in putting right the calculations and making the job airworthy. By that time, the power plant originally envisaged would probably be obsolescent. He would stress again the urgent necessity of coming to an international agreement on friction lines. Unless that could be done quickly the world's experimental tanks would resemble the Tower of Babel, with everyone using a different friction language.

Dr. Ing. K. A. G. Kempf considered that the paper had many merits. The first was that the author had dared to "put up again a hot iron"; secondly, he had put forward some really new ideas; and thirdly, by the application of those ideas he had brought into agreement many experimental results obtained by different experimenters, using various methods. As an old sinner in the field of local and total friction experiments, adding to the mass of other experimental results which had been recorded, Dr. Kempf apologised for having himself complicated the matter; but he hoped that some day, as the result of Mr. Lap's paper, all those different methods would run together into a single equation, perhaps of such a form as the author had given.

The author's deductions were very plausible and the agreement between the different results for small plates, pontoons, pipes and ship forms was rather interesting. Especially, he remarked, the curve for the Lucy Ashton seemed to agree very well with the results of experiments with eight models having a smooth surface, and with the results for the ship, the roughness of which was some 10 per cent. higher. In general, it must be a sad thing for practical people that their endeavours to find the lowest line for a smooth surface had not so much to do with the reliable prediction of ship performance from model tests; the percentage differences between those suggested lines were very small. The very practical problem of making a sound prediction was largely a matter of the roughness of the hull skin; it was a question of how smooth a surface could be achieved in the shipyard. In that respect also the author's remarks and his deductions were interesting and worthy of study.

Dr. R. W. L. Gawn, C.B.E., described the paper as "an attractive expansion" of that previously published by the author in association with Professor Troost in 1953. The basic formula then established received some support from his additional experimental information from tests on geometrically similar model hulls, pontoons, plates and pipes. Substantial adjustments of the numerical values of the constants in the formula were involved for different applications, but there were significant differences between the various hull forms considered. The author's extrapolator varied because it included form effect and, accordingly, was three-dimensional; two-dimensional formulations from plank tests tacitly assumed that form effect was included in residuary resistance. Neither approach could be really true physically, unless the form effect could be determined physically, since viscosity and wave-making were interdependent. He emphasised that point. Essentially, therefore, they were considering an empirical or partly empirical formulation with a good physical background, and, as such, the evidence of the consequent ship predictions must be borne in mind when assessing the practical validity of the law. Perhaps the author would indicate the relation between the effective horse-power over the speed range predicted by his formulation for the ships corresponding to each of the four models for which results were given, and the values obtained from, say, Froude and Schoenherr coefficients.

He was a little worried about the determination of the appropriate value of the parameter A for a specific hull. In principle, it could be determined from a model test, as mentioned by the author; but it would be difficult to avoid uncertainty in practice, since the speed of the test must be low enough for wave generation to be negligible, and yet sufficient to avoid laminar flow. Artificial turbulence stimulation might dispose of the latter, but a small correction was then called for, depending on the particular type of stimulation adopted; that again could lead to some lack of precision in the present state of knowledge. He asked if the author would comment on the overall accuracy of the method from his experience. It appeared that the local friction would not be significantly different from the values derived from Schoenherr's and some other formulations. Similar remarks applied to local and total friction, and to the results for the pontoons. That seemed to indicate some alignment with other formulations over the experiment range so far as flat surfaces were concerned, but it by no means followed that the law could be safely extrapolated.

The ship zone of any formulation was at least as important as the model zone. There was at present no real information to confirm ship skin friction, and verification was essential before arriving at a firm opinion concerning any formulation. It was probable that reliable information in that respect would be available in the future from the promising investigations in progress in the Netherlands and elsewhere. It was to be hoped that the author would continue his work and subject his proposals to review when reliable ship results became available. For the present, Dr. Gawn's inclination was to suspend judgment until a check was forthcoming. Perhaps, also, he suggested, the author would endeavour to simplify his symbols and to align them with the B.S.R.A. nomenclature, which would make them better for

reading. William Froude, in a remarkably quick assessment of what was, by modern standards, not a large range of plank tests, advised by wise logic that the truth must lie between two alternatives which were not very far apart. The truth was difficult to establish, but the paper was a valuable step in that direction.

Mr. V. A. Sentic thought that the author had treated the problem of frictional drag in an ingenious way; shifting the extrapolator line to the values of the resistance coefficients at non-wavemaking speeds represented a revolutionary idea which was very promising. The only deficiency in the practical application of this method seemed to lie in the fact that log A was calculated from the results of the measurements made at non-wavemaking speed, at which speed it was difficult to obtain consistent results because of unstable flow round the model hull. For practical work with models, it might be more convenient to develop the method in such a way that the form factor would be determined for a higher standard speed, at which there was no danger of laminar or mixed flow. For those who were working in experimental tanks it would be useful to split the residuary resistance into pure wave resistance and form drag; it would show the way in which to start when trying to improve a hull form. He believed that the author's ideas would enable that to be done.

Ir. Lap, replying briefly to the discussion, agreed with Mr. Barnaby that it was difficult to determine whether or not experiments were reliable; therefore he thought it important that the analysis of the different experiments should be based on a formula which had a certain theoretical background. If the experiments were in agreement with the theoretical background, that was an indication that the formulation might be correct; but it was not 100 per cent. certain that it was correct, because it could not be proved. Mr. Barnaby asked if it were possible to give a simpler formulation; in the original paper by Lap and Troost a simple formulation was given, but he had not given it in the present paper because he did not wish to complicate matters and so he restricted himself to the logarithmic formulae, which could be used just as simply as the simple formula.

SMOOTH SHIP IMPORTANT

It had been remarked that, for practical people, the value of the new skin-friction formulae was that they showed the frictional resistance of a theoretically smooth ship to be lower than had been thought. That was important for shipowners especially, because it should inspire them to make the hulls of their ships as smooth as possible. In his opinion, much money could be saved by work in that field. He agreed with Dr. Gawn that, in the absence of watertight proof of the correctness of the formulae proposed by different people, it could not be claimed that one extrapolator was absolutely correct. Nevertheless, they must try to give an extrapolator which was as good as possible. Dr. Gawn mentioned the differences between the form factors. It would be interesting to make predictions for several types of ships, differently extrapolated. That was not done in the paper because it would have made the paper too complicated.

As to nomenclature, they were in a very difficult position in Holland; they were living between two schools of nomenclature, the German and the English, and it was very convenient to be able to publish a paper in several countries, using a given nomenclature. He had a great admiration for William Froude's experiments. The first experiments that he carried out, more than 80 years ago, had lost none of their value; as a matter of fact, it was still the principle of William Froude that was used to-day. He believed that Froude's principle would always be used; the question was merely which correction should be used.

Mr. Sentic mentioned the difficulty of the suggested method of calculating frictional resistance, and the determination of the value of the form factor at a very low model speed. In fact, if sufficient care was taken in stimulating flow, it was possible to obtain fairly reliable values for the form factor; it was very important that, in determining the form factor, any error that was made should be small. If it was possible to standardise form factors, the tank experimenters could use the standardised factors; they might not be 100 per cent. correct, but the influence of such error as existed would not be very great.

EVENING TRIP

The fact that only one paper was considered at the afternoon session enabled the party to make a trip of some four hours duration, in the early evening, down the Bay of Kvarner and among the neighbouring islands, as the guests of the Association of Yugoslav Shipyards and the Association of Yugoslav Shipping Companies. The vessel, the small passenger motorship Vuk Karadzic, attracted much favourable comment as an example of Yugoslav shipbuilding. In the course of the cruise, she passed close to the shipyard at Kraljevica, formerly operated by Yarrow and Company, which has been largely reconstructed since the end of the war.

(*To be continued*)

CONCRETE AND STRUCTURAL FORM

THE SYNTHESIS OF ENGINEER AND ARCHITECT

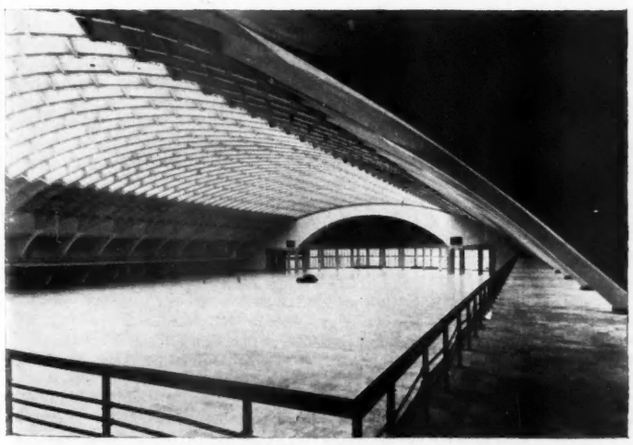
As a structural material, concrete has been used throughout this century and as the lessons of experience have been learnt so an architectural form has been developed. Foremost of the exponents of the medium is Professor Pier Luigi Nervi. Among the magnificent buildings for which he has been responsible are the Exhibition Hall at Turin, illustrated below, and the Railway Station at Naples. On Friday, October 14, *before an audience of several hundred engineers and architects at Friends House, London, Nervi gave a lecture illustrated by lantern slides; extracts from his lecture are given below. The meeting was organised by the Institution of Structural Engineers and the Joint Committee on Structural Concrete (representing the Cement and Concrete Association, the Prestressed Concrete Development Group and the Reinforced Concrete Association).*

I am very honoured and deeply grateful for this opportunity of meeting my English colleagues and of talking to them about some of the work I have done in the course of an already long career as designer and constructor. I should make it clear that I both designed these works and was responsible for their construction as partner and technical director in the firm who built them. And I must say, also, that this opportunity of uniting these two aspects of the construction process—design and execution—which have tended more and more to separate into two distinct functions, has greatly contributed to any success I may have achieved.

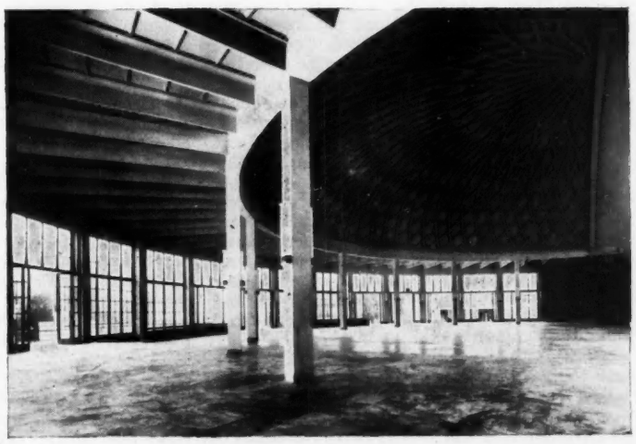
TENDERING

The fact that design and actual construction could be united in this way was due to the method of placing contracts, known as the "competition-tender," which is already fairly widespread and is tending to be increasingly used in Italy. The method consists of inviting a number of firms, known to be well qualified from the technical point of view, to submit a tender including the actual design as well as a price quotation. The design is based on an outline provided by the commissioning authority and these outlines always allow ample freedom for the best architectural and structural solutions to the problem. Design and tender are sent in as in all normal competitions of this kind. The commissioning authority makes separate examinations of the technical and the economic data and selects the design which seems the most satisfactory from all points of view.

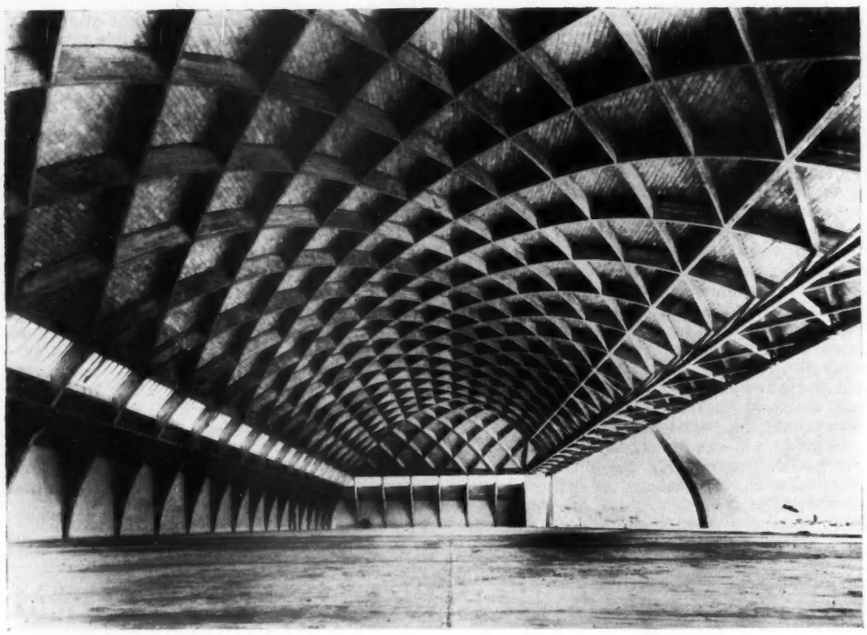
A design that is good from the aesthetic and technical points of view is nearly always sufficiently economical; in any case, the commissioning authority has full data on which to base a



The Exhibition Hall at Turin. The main Hall has a span of 330 ft. and the roof, of ferro-cement, is built of 8 ft. wide pre-cast "corrugations."



The elegant tracery in the half dome in the vestibule is reminiscent of the best Gothic architecture, yet the Hall was constructed in eight months.



An aircraft hangar built at Orvieto in 1938. The barrel roof was built in traditional reinforced-concrete fashion using shutterwork. In the post-war period, economy of material and labour as well as a need for a superior finish, have encouraged the use of pre-cast members for such work.

choice and may even accept a tender which is not the lowest, if the qualities of the design are such as to outweigh a small difference in cost. In some cases, the invitation to tender asks for a lump-sum contract, so that, except for unforeseen circumstances, the commissioning authority knows how much the finished work will cost.

The advantages of such a system are obvious. Competition stimulates the designer-contractor to develop the most suitable design from the economic as well as from the technical point of view, and to study new and more efficient building methods for its execution. The extensive knowledge of materials which he possesses as a practical contractor, his realisation of the limitations and difficulties of the actual execution and his study of means of overcoming them will, on the one hand, ensure a realistic approach to the design, but they may also suggest daring, yet rational solutions, that might have seemed impossible to the purely professional designer. Moreover, the designer-contractor can carry out preliminary tests and experiments—even quite costly ones—within his own organisation, where this would be practically impossible for the purely professional man.

It seems to me necessary to make these points clear, in order to emphasise what I consider the most important characteristics of my works: that they are the result of a constant endeavour to find the most efficient design from the technical and the economic point of view. All my designs, even those that might seem to have been developed on more formalistic lines, are, therefore, the direct result of structural or constructional considerations.

Moreover, I am deeply convinced—and this conviction is strengthened by a critical appraisal of the most significant architectural works of the past as well as of the present—that the outward appearance of a good building cannot, and must not, be anything but the visible expression of an efficient structural or constructional reality. In other words, form must be the necessary result, and not the initial basis, of structure.

AIRCRAFT HANGARS

A particularly interesting opportunity was given to my firm in connection with the competition organised by the Italian Air Force authorities in 1935 for the construction of large hangars spanning 330 ft. by 135 ft. internally, with door openings of 165 ft. span.

I designed the structure as a geodetic framework acting together as a whole, as I believed this would give the most economical solution and the one requiring the least steel. With this type of design the theoretical calculations were extremely complicated; I therefore decided to make a preliminary calculation and then to make a detailed study of the stresses by means of experiments on a model. The model experiments were carried out at the Milan Polytechnic, under the direction of Prof. Ing. Danusso and Prof. Ing. Oberti; I believe this is one of the first instances in which the results of model tests have been applied to a really large-scale building structure. The results of the model tests enabled me to go fully into the static behaviour of the structure and to estimate the stresses in the whole framework, and it was found that the estimates provided by the preliminary calculations used in the construction of the model required hardly any alteration.

The actual construction was not easy, and provided yet another illustration of the economic disadvantages of timber formwork wherever reinforced-concrete work goes beyond the simplest shapes. The hangars are illustrated above.

In 1940 the Italian Air Force authorities invited new tenders for the construction of hangar No. 6, of similar dimensions. At that time, the need for economy in materials and timber had become even more acute and this is why, on the basis of the experience acquired, I decided to simplify and lighten the structure by designing the ribs as a lattice, which would enable me to make use of prefabrication. I also altered the system of supports in order to simplify the static system and make it more symmetrical.

In this case again, model tests were carried out. The greater structural simplicity and the extensive study made of the previous hangar design enabled me to make a still better approximate calculation, the results of which agreed closely with those of the model tests.

The pre-casting of the units and their erection proved quite simple. The method of assembly had been tested by my own firm, in its workshops, and in the laboratory of the Milan Polytechnic. The joints were made by welding the steel and placing high-strength concrete *in situ* in the space left at the junction of four units. The results were excellent, as may be observed on visiting the remains of the six hangars. The Germans destroyed them when they retreated by demolishing the supporting columns, but even after the fall of the roof, the great majority of the joints are still intact.

FERRO-CEMENT

Meanwhile, conditions at the time had led me to work on a new type of construction that I called "ferro-cement." It is based on the principle of a very thin highly reinforced slab obtained by forcing a very good quality cement mortar, made with cement and sand, through several layers of steel mesh and small diameter bars, joined together to form a section only a little thinner than the final unit. The mortar was placed either by hand or by vibration and the results were extremely promising, not only because of the exceptional flexibility, strength and freedom from cracking of the slabs so obtained, but even more because the mortar being held by the mesh, one could greatly simplify the framework or even do away with it altogether.

This new method was devised mainly for the quick and simple construction of small ships of a tonnage not exceeding 500 tons. In 1943, work was started on three motor-transport boats for the Italian navy and one sailing ship, with an auxiliary motor, for private industry. The events of the war prevented the completion of this work, but in 1945 my firm built the yacht Irene which is still in use and in perfect condition, and in 1948 I adapted the method to build a 40 ft. ketch, the Nennele for my personal use. The hull of the Irene is 1½ in. thick, that of the ketch Nennele ½ in. thick.

These designs, and others, both for ships and buildings, which it would be too long to describe, gave me the necessary experience to attempt, in 1948, a much greater work—the roof of the Exhibition Hall at Turin, illustrated on page 601.

EXHIBITION HALLS

In this case again, my firm was invited, along with several others, to submit a design and tender for the construction of a large exhibition hall in Turin, to replace the Palace of Fashion destroyed during the war. The problem was particularly interesting, not only because of the dimensions of the hall (nearly 330 ft. span) but also because of the very short time allowed for the execution of the work, which was to start in September and had to be finished by the end of April. This very short time was a real problem in view of Turin's difficult climate.

The solution I immediately thought of was a structure in corrugated ferro-cement, which would attain the necessary stability by virtue of the corrugations and would enable us to use pre-casting, as in the case of the hangars, and to manufacture the roof units while the floors and supporting structure were being built.

On this basis I designed a roof structure with corrugations of about 8 ft. span, divided into units about 13 ft. long. The units were to be made of ferro-cement in order to be as light as possible (thickness 1½ in.) and would be rendered monolithic by reinforced-concrete ribs cast *in situ*, and located at the peaks and troughs of the corrugations. In this way the ferro-cement units would act as junction units between the *in situ* ribs which in torn would take over the main structural work.

The units are closed at each end by stiffening diaphragms and adjacent units are joined together by a 1½ in. thickness of mortar placed *in situ*.

The casting of the units proceeded without any difficulty and without the need for double formwork, as would have been the case with ordinary reinforced concrete. Because of the richness of the mortar (800 kg. of best quality cement to 1 cub. m. of sand), the units could be de-moulded in either two or three days, according to the outside temperature. Lifting and placing the units proceeded regularly and enabled about 3,230 sq. ft. of roof to be completed each day. The construction took place in three stages, to get the fullest possible use from the movable formwork. The corrugated roof was connected to the main supporting columns (which are at 24 ft. 7½ in. centres) by fan-shaped ferro-cement units springing from inclined reinforced concrete elements.

"Irene." The hull and cabin are both of ferro-cement, 1½ in. thick, though the masts are of conventional materials.

Quite apart from the essentially subjective judgment of its architectural aspect, which may or may not be found pleasing, a purely objective judgment will show how the problems of structural efficiency, economy, thermal insulation, provision for air-conditioning ducts, natural lighting and, more especially, acoustics and sound absorption (very important factors in large buildings) have all been simultaneously solved. I have, moreover, often observed that a design that is sound structurally is generally satisfactory in every other way.

For the design of the 130 ft. diameter half-dome at the end of the main Exhibition Hall in Turin I used a method, based on pre-cast units, which I had studied and actually used, though on small-scale structures, immediately after the war. This method had also been inspired by the need for economising in timber, which was extremely scarce in Italy at that time.

The method is suitable for the construction of vaults or domes and consists in filling the space to be covered with pre-cast units measuring approximately 6 ft. 6 in. by 13 ft. The units are cast in concrete moulds which in turn are constructed on a model reproducing a section of the vault or dome to be built. The edges of each unit are so shaped that when placed side by side they form channels about 4 in. wide between the units, which are filled with *in situ* reinforced concrete and form a network of supporting ribs that completes the structural system. The units, ¾ in. thick, are made of ferro-cement and during erection are supported on scaffolding, thereby requiring no actual formwork. The units may be made in any shape and, provided allowance is made for the formation of the ribs, they lend themselves readily to the expression of any architectural form.

ROOF CONSTRUCTION

A new method for the construction of roofs, based on ferro-cement moulds mounted on travelling scaffolding, movable both horizontally and vertically, which I designed in connection with an important competition, enabled me to free the construction of the ribbed roof from the restrictions imposed by timber formwork. This new freedom made it possible, not only to profile and position the main and secondary beams according to constructional convenience, but also to design roofs with ribs located along the isostatic lines of the principal bending moments, a design which makes possible strict adherence to the laws of statics and, therefore, makes the most efficient use of the materials.

It is interesting to observe the harmonious effect and the aesthetically satisfying result of the interplay of ribs placed in this way—a clear reminder of the mysterious affinity to be found between physical laws and our own senses.

OBJECTIVE DESIGNS

These observations, you will notice, all point to the fundamental importance of purely constructional problems in the design of reinforced-concrete structures. The buildings which I have had the pleasure of showing you would in the main have been impossible to build if the method of construction had not been studied from beginning to end as an integral part of the design.

I also want to emphasise that the full development of reinforced concrete, not only from the engineering, but also from the architectural point of view, is closely linked to a gradual liberation from the restrictions imposed by timber formwork, which in fact obliges the designer to conform to the pattern of timber construction, and is in direct opposition to the plasticity of form that is the most important structural and architectural characteristic of reinforced concrete. I believe that pre-casting, the use of ferro-cement, and methods of roof construction with travelling ferro-cement formwork, may be a not unimportant step in this direction.

In closing, I should like to mention the contribution that reinforced concrete has made to the development of present-day tendencies in architecture. After the first unfortunate attempts to adapt the new material to the structural forms of masonry or timber, reinforced concrete, spurred on by technical requirements and by its own unlimited possibilities, turned very quickly towards new structural forms, which, to the surprise of their inventors themselves, were found to possess an inherent beauty of their own.

It can be said that the most characteristic architectural forms of reinforced concrete in these last few years have been at once the cause and the consequence of a widespread orientation towards a genuinely constructional architecture, which has very quickly reached every country and every aspect of construction. Perhaps, because we are taking part in it ourselves, we do not sufficiently realise how profound is the change between the architectural concept of the first part of this century and of the present day, and how important it is to have freed architecture from a complex of rules and traditions which, however much they correspond to structural reality at the time of their inception, have gradually lost any significance and become a sterile formalism.

The present moment in architecture is full of promise, but the danger of slipping into structural formalism should never be overlooked: alarming symptoms of it can already be seen in the architectural work illustrated in the periodicals of all countries. This derives from the fact that too often, through a lack of understanding of its structural and constructional essence, a structure is considered solely on the basis of its external appearance—which people try to adapt to a variety of different problems, both as regards dimensions and strength.

The result is always unfortunate. I am absolutely certain that the prime condition of architectural expression in a structure is the correctness and, I might say, the inevitability of its structural design. Constructional complications, or designs that require structural acrobatics, are always a sign of a false structural conception—even to the untrained eye of the non-technical observer.

A consideration of this danger brings us to what, to my mind, is now the most important problem in architecture: the training of the architect of to-morrow.

To deal worthily with the ever more ambitious architectural projects of the near future the architect must possess—and synthesise in himself—aesthetic sensibility, profound understanding of structural needs, and a precise knowledge of the methods, possibilities and limitations of constructional techniques. The organisation of a course of studies which could in a reasonable number of years provide such a wide and varied training is certainly a very difficult problem. But if we cannot by suitable training succeed in uniting in the young constructor artistic sensibility, technical wisdom and knowledge of building methods, the hopes of the new architecture will be to a great extent frustrated.

ENGINEER AND ARCHITECT

Meanwhile, until such time as the training of the complete architect can be achieved, good results can be obtained through the sincere collaboration of different people, each contributing the specific knowledge lacked by the others. Architect, engineer and constructor can, in this way, bring about that union of art and science that is necessary to the solution of any constructional problem.

In the last few years I have had the opportunity of collaborating with architects of great capacities and artistic sensibility, in the conception and development of several outstanding projects, and I must say that this collaboration has been carried out with mutual satisfaction and with results which I consider interesting. I would mention in this connection the U.N.E.S.C.O. building in Paris, in which I collaborated with the architects Breuer and Zehrfuss; the Pirelli offices in Milan, a notable architectural conception by the architects Ponti, Fornaroli, and Rosselli, studied in collaboration with Professor Danusso, and engineers Valtolina and Dall'Orto; the project for the new Central Station at Naples, carried out in collaboration with the architect Vaccaro.

I have also observed that the contribution of technical-constructional knowledge is only effective if it is brought into collaboration with the architect from the inception of the scheme; as with living creatures, it is very difficult to eliminate in the development stages any initial deficiency or malformation. It is clear that the whole field of construction, which stretches from the cultural formation of the architect on the one hand to the industrial organisation of construction on the other, is in a state of rapid and progressive development which demands a bringing up to date of both ideas and techniques. All the efforts of those who have at heart the progress of architecture will still be inadequate to define, to study and to solve so many and such complex problems.

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THE STRENGTH OF CONCRETE STRUCTURES

London Symposium: May, 1956

A symposium on the strength of concrete structures is to be held at the Institution of Civil Engineers, Great George-street, London, S.W.1, on Wednesday, Thursday and Friday, May 16 to 18, 1956. It is being organised by the Cement and Concrete Association in conjunction with the Joint Committee on Structural Concrete.

With the likelihood that, as on the Continent, the design methods based on the ultimate strength of reinforced and concrete structures will be incorporated in British codes of practice, it will be of considerable value for designers and research workers to get together to discuss mutual problems. Among the contributors listed in the provisional programme are Dr. M. R. Horne, Mr. A. J. Harris, Dr. K. Hajnal-Konyi, Professor A. L. L. Baker, Monsieur Y. Guyon, Dr. P. B. Morice and Dr. D. D. Matthews.

Membership of the symposium is free to all those interested and forms of application may be obtained from the Organising Secretary, Cement and Concrete Association, 52 Grosvenor-gardens, London, S.W.1. The forms should be returned not later than Saturday, April 7, 1956.

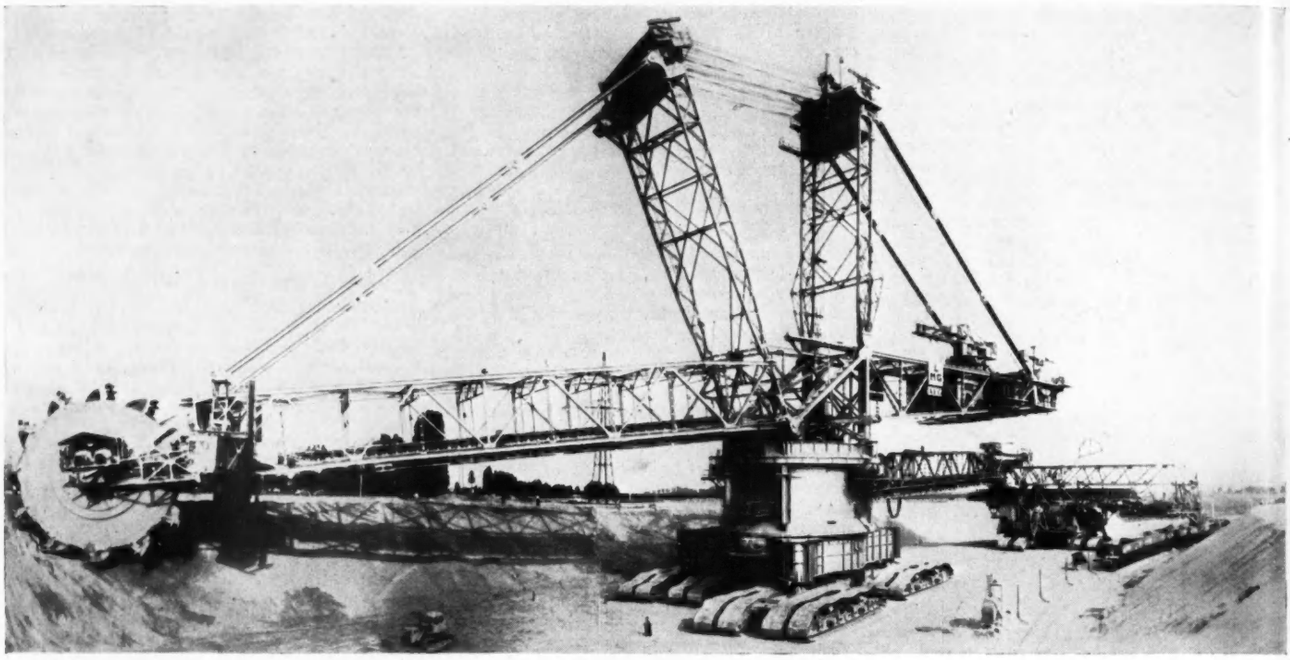

Fig. 1 The Orenstein-Koppel bucket-wheel excavator will handle 100,000 cub. m. of material a day, and load it into railway wagons.

BUCKET-WHEEL EXCAVATOR

247,000 TONS OF OPENCAST COAL CUT AND LOADED AWAY EACH DAY

Opencast mining is the oldest method of working coal and many other minerals, but it was only with the advent of the mechanical excavator that it became possible on a large scale. To-day it is customary to remove the overburden, pile it temporarily while the mineral is extracted, and then return and level it ready for re-use for agricultural purposes. Large quantities of minerals are now worked by opencast methods which would, even in comparatively recent years, have had to be won by shallow underground mining, and the thicknesses of overburden removed are considerable. The excavators used in modern opencast mining are therefore often very large, and capable of moving many thousands of tons of material in a single working shift.

A bucket-wheel excavator built by Orenstein-Koppel und Lübecker Maschinenbau A.G., Lübeck, Germany, is claimed to be the largest of its kind in the world. It is installed at the Fortuna opencast brown coal mine of the Rheinische A.G. für Braunkohlenbergbau und Brikettfabrikation, Cologne, Germany, where it is used for both overburden stripping and coal winning. Working three shifts, with an uninterrupted operating time of 19·4 hours, the excavator has a daily output of 100,000 cub. m. (about 247,000 tons). The problem of disposing of the material is considerable, and the excavator incorporates plant for loading railway wagons. The excavator (Fig. 1) has an overall length of 200 m. (656 ft.), and weighs 5,600 tons. The maximum depth of cut is 25 m. (82 ft.) below general ground level.

The excavator consists of three main units; the bucket-wheel excavator itself, a connecting bridge approximately 80 m. (262 ft.) long, and the loading plant, which disposes of the excavated material continuously into railway wagons.

BUCKET-WHEEL OF 52 FT. DIAMETER

The bucket-wheel (Fig. 2), has 12 buckets,with a lip-circle diameter of 16 m. (52 ft.), each bucket having a capacity of 3·6 cub. m. The wheel rotates at 2·3 r.p.m.; 27 bucket-loads are thus excavated during one minute. Material cut by the bucket-wheel passes by a total of seven belt conveyors, 2,600 mm. (8 ft. 6 in.) wide, through the jib carrying the bucket-wheel to the central structure of the excavator, and thence to the loading plant. The bucket-wheel jib is suspended from the excavator frame by a 24 rope block, and the hoisting winch and block have two independent suspension systems. It is thus possible to change a hoisting rope without the need for any special means of supporting the jib while the work is done. A built-up counterweight girder, with approximately 310 tons of counterweights, extends from the main structure on the side opposite to the bucket-wheel jib.

INDEPENDENT ROTATION OF EXCAVATOR AND LOADING PLANT

The superstructure, consisting of the jib and counter-weight girder, rests on a ball-path 15 m. (49 ft.) diameter containing 156 hardened steel balls each 150 mm. (5·9 in.) diameter. These load-carrying balls are spaced by separating balls 148 mm. (5·8 in.) diameter. The ball-path is designed to accommodate all vertical and horizontal forces transmitted to it by the superstructure, and to allow of rotation through 360 deg. A coal-crusher for reducing the size of coal to a maximum of 500 mm. (19 in.) is incorporated in the superstructure. The crusher can be by-passed when overburden is being excavated.

Underneath the superstructure there is a cylindrical central unit which is also supported on a ball-track of the same construction as that used for the superstructure. The conveyor leading to the loading plant is carried by the central unit, and it is thus possible for the loading plant and the excavator to be slewed through 360 deg. independently of each other, so that the complete plant can be disposed as required.

CRAWLER MOUNTING

Both the excavator and the loading plant are mounted on crawlers. The excavator itself stands on three crawler units having a total of 12 tracks; each crawler track is 15·2 m. (50 ft.) long between the return sprockets. Two of the

Fig. 2 The excavating unit is a bucket-wheel with 12 buckets and a lip-diameter of 52 ft. Each bucket has a capacity of 3·6 cub. m. and 27 bucket-loads are excavated each minute.

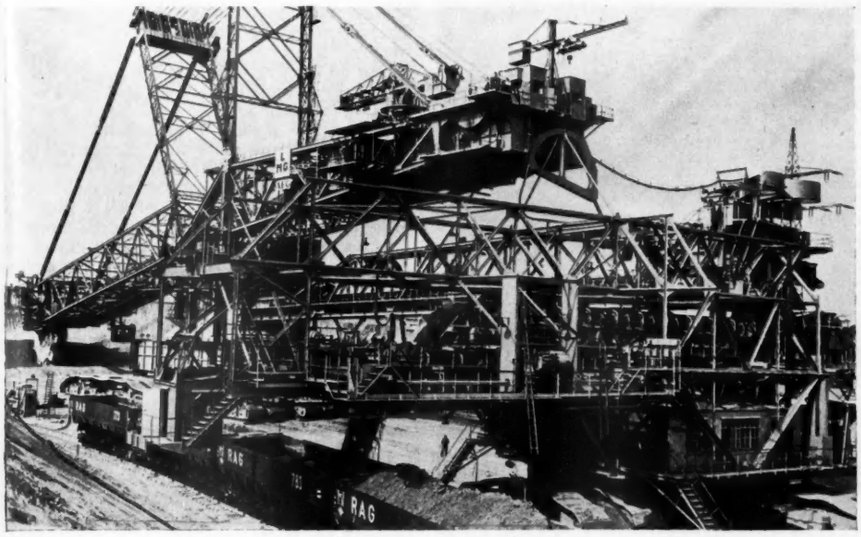

Fig. 3 Excavated overburden or coal is loaded into wagons on either of two parallel rail tracks.

tracks are arranged in line, as can be seen in Fig. 1, and these tracks can be adjusted to curves, so that the excavator can move in either a straight line or in a curved path with a minimum radius of 50 m. (164 ft.).

Each crawler track has 924 treads and 192 load-carrying rollers, giving a total ground contact surface of 456 sq. m., and a unit pressure of 1·25 kg. per square centimetre. Nine of the crawler tracks are motor-driven through dust-tight and water-tight reduction gearing, and the travelling speed can be varied steplessly up to a maximum of 10 m. (32 ft.) per minute. Lubrication of the reduction gearing is by oil under pressure; grease points are lubricated by a Helios centralised pressure-lubrication system.

Several travelling cranes are mounted on the excavator structure for maintenance purposes, including one of 15 tons capacity on the upper counterweight girder.

WAGON LOADING

A bridge of 80 m. (262 ft.) long connects the excavator to the loading plant (Fig. 3), and a conveyor belt extends along this bridge. This conveyor discharges on to two reversible belts mounted on a crane-type carriage in the loading structure. The main conveyor can be slewed in a horizontal plane to deliver on to either of the reversible belts, or, by means of a saddle-chute, on to both. The reversible belts can then be used to load wagons on either of two parallel railway tracks, or to load to both tracks simultaneously, as shown in Fig. 4. The carriage traverse of the loading belts makes it possible for the material to be deposited along the whole length of each wagon. Dust-catching belts are fitted below all the conveyors to deal with any possible spillage. The railway wagons used for disposal of the excavated material are all of the automatic-tipping type, with a capacity of 96 cub. m., and are hauled by electric locomotives.

ELECTRICAL EQUIPMENT

The electrical loading of the complete plant is 10,300 kVA, distribution being arranged through eight switchgear houses located in the counterweight section, the cylindrical central unit, the undercarriage and the loading plant. All the electrical equipment was supplied by the Allgemeine Elektrizitäts-Gesellschaft. The main supply, of 25,000 volts, 50 cycles, alternating current, is fed to the plant by a trailing cable, which is wound on to a spring-loaded drum on the excavator. This current is stepped down to 3,000 volts, 500 volts, and 220 volts in 11 transformers located in the excavator. Two batteries, with a total capacity of 300 ampere-hours, provide an emergency lighting supply at 110 volts should the main supply fail.

There are approximately 120 electric motors, the principal ones being as follows: the bucket-wheel has two 3,000 volt motors, each rated at 525 kW. The bucket-wheel belt conveyor also has two motors, of 3,000 volts and each of 500 kW rating. For raising and lowering the bucket-wheel jib there are two motors with Ward Leonard control and a total rating of 1,300 kW. Two motor generators supply the current for the jib-winch motors. Nine motors, with Ward Leonard control, are used for driving the excavator tracks. These are rated at 100 kW each, and are supplied with current by motor generators similar to those used on the jib-winch. A motor rated at 220 kW supplies the power for steering the excavator tracks. Movement of the loading belts and the slewing of the main feeding belt are also effected under Ward Leonard control.

SMALL OPERATING CREW

The excavator is controlled by one of two drivers from a cabin at the bucket-wheel, and the loading tracks are under the control of two loading supervisors, who also control the locomotives of the overburden or coal trains by means of ultra-short wave radio. A further one or two men are needed for the control of the remaining mechanical and electrical equipment, and the whole plant is operated by these five or six men. Telephone communication is provided between the drivers and the loading supervisors.

The design of the excavator allows for the working of blocks of ground 40 m. (131 ft.) high and 89 m. (292 ft.) wide, in segments one below the other, each segment having a height of 10 m. (33 ft.) and a depth of 19·2 m. (63 ft.). The bucket-wheel is swung through an arc in the horizontal plane to cut each segment, each individual bucket-wheel cut being approximately 1·2 m. (4 ft.) in depth. This depth is set by driving the excavator forward on its tracks. The arc of each segment cut is set forward relative to the one above it (Fig. 5), and the resulting overall slope of the face is 36 deg.; face-slipping, even in bad ground, is thus minimised.

The drivers' cabins are arranged so that they can be raised or lowered over a range of 6 m. (19 ft.) by means of a rope and winch, to give the driver the best possible view of the working of the bucket-wheel. The controls are located on the arms of the drivers' seats. Further controls are installed at the drivers' feet, and these are used for controlling the automatic cycle. Once the limit positions, cutting depth, slewing and travelling speeds have been set, the operation of cutting a complete segment is controlled by push-button.

Control of the loading operation is by means of two concentric handwheels in front of the loading supervisors, the necessary intruments being mounted on the ceiling of the control cabin. Automatic visual and audible signals give warning of any plant failures.

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NUCLEAR INFORMATION

Developments in the entire field of atomic energy and its by-products, from mining of the basic minerals, through reactor technology to the application of radioisotopes, will be covered in a weekly report, issued by Comtel Reuter. Known as " Applied Atomics," it may be obtained from, Comtelburo Limited, 85 Fleet-street, London, E.C.4.

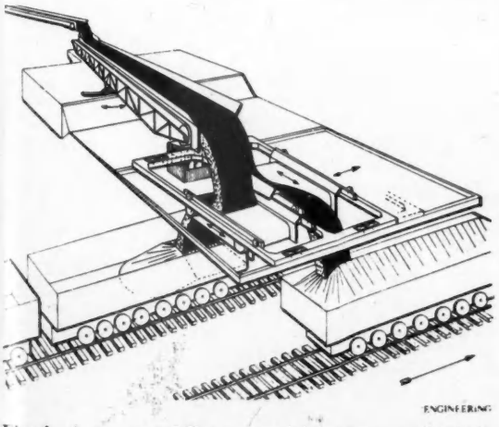

Fig. 4 A conveyor delivers material to two reversible belts, which discharge to either rail track as required.

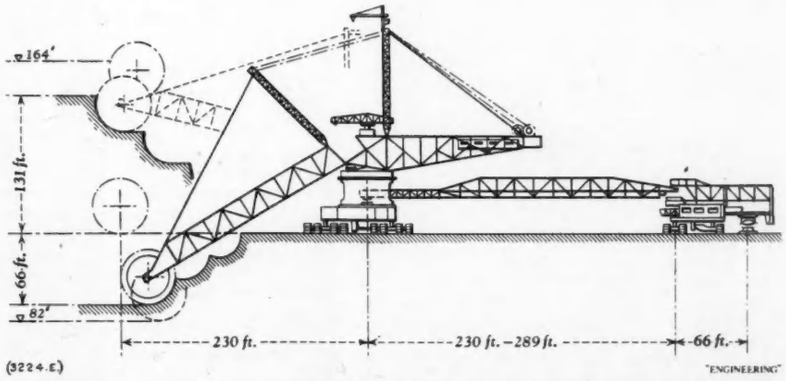

Fig. 5 The excavator makes radial cuts into the face, leaving an overall slope of 36 deg., which minimises face-slipping.

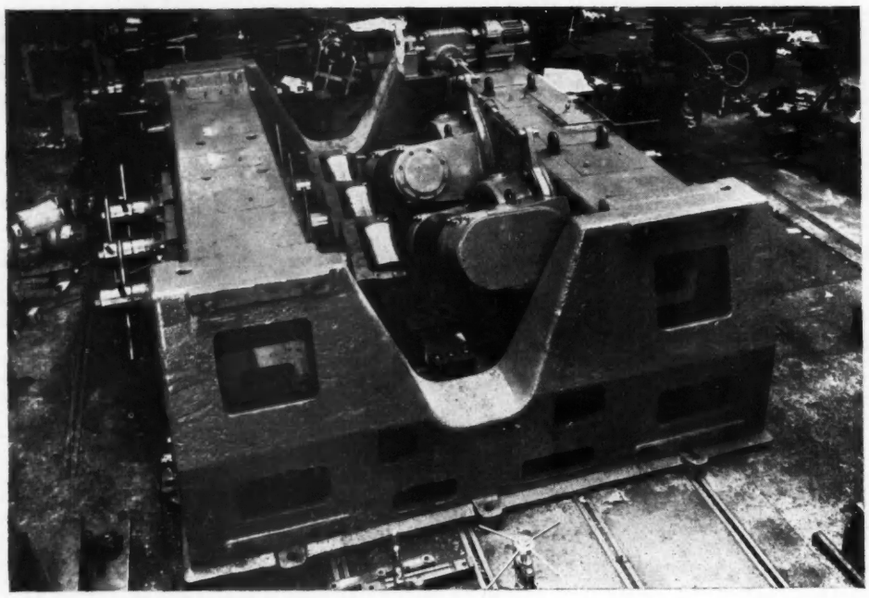

Fig. 1 Steel tubes from 3 in. to 15 in. in diameter and up to 44 ft. long can be straightened in an automatic operating cycle on this Bigwood machine.

HIGH-SPEED STRAIGHTENING OF STEEL TUBES

LARGE DIAMETER RANGE AND AUTOMATIC OPERATION

A machine which is claimed to be the largest yet made in this country for tube straightening has recently been completed by Joshua Bigwood and Son, Limited, Wolverhampton. It will be used in the production of high-grade, hot-finished steel tubes for oil pipelines, and is designed to operate over a diameter-range of 3 in. to 15 in., though it will normally be used for tubes 9⅝ in. in diameter, with ⅝ in. walls in special alloy steels.

The machine is of the multiple inclined roll type, in which a number of idle and driving rolls are disposed along the tube. The driving rolls, by helical contact, rotate the tube and pass it through the machine, and as it is traversed along, pressure is applied by the idle rolls to stress the material in the tube walls beyond its elastic limit.

OPEN CONSTRUCTION FOR EASY SCALE DISPOSAL

The rolls are so disposed that the tubes pass through the machine in a horizontal line, and they are carried in a heavy box-section housing consisting of four steel castings, a drive housing, a front housing and two side housings. The side housings are shouldered to receive the front and rear housings; straightening loads are thus taken by the castings, and tie-bolts are only needed to fasten the four sections rigidly together. The centre of the machine, between the rolls, is completely open, all working parts being clear of the tubes being straightened, and scale from the hot tubes falls directly into a pit built into the machine foundations, which can be emptied as required.

Five working rolls are fitted, two at the rear for driving and three at the front for providing the working pressure. Because of the large tube-diameter range for which the machine is designed, it is necessary to provide means for adjusting the rolls angularly, so that they can be set to bear against the tube over their whole length, whatever the diameter may be, to eliminate any possibility of marking or crushing the tube.

The two driving rolls, which are of chilled cast iron, run in heavy-duty roller bearings carried in swivelling brackets, which are located in machined circular recesses in the drive housing. The weight of the driving roll assemblies makes it necessary to adjust them angularly by power; an electric motor and gearing are therefore provided. The angular position of the rolls is indicated by a dial, which is visible from the remote push-button station controlling the setting.

The three idle rolls, which also run in heavy-duty roller bearings, are carried in steel forks, which are angularly adjustable in the idle roll chocks. Adjustment is by hand, and the forks, when set to the required angle, are locked by bolts operated from the front of the machine. The idle roll chocks are mounted in machined slideways in the front housing, and they can be spaced along the machine to suit the diameter and material of the tubes being straightened. The slideways are fitted with phosphor-bronze wearing strips to minimise sliding friction. Linear adjustment of the chocks along the slideways is by a single hand-wheel at the side of the machine, selector levers on the chocks enabling all or any one of them to be moved as required.

Straightening pressure and diameter adjustment for various sizes of tube are set by advancing or withdrawing the idle roll forks in their chocks by means of screws and hand-wheels, a ring scale being provided so that settings can be repeated. Locking bolts are fitted to all adjustments, to prevent movement due to vibration when the machine is operating; they are all controlled from the front of the machine. Scales are provided to show the position of each idle roll relative to the driving rolls. It should be added that although the adjustment of the idle rolls is by hand, it could easily be adapted to power operation if required.

ENCLOSED DRIVE

Each of the driving rolls is equipped with crown wheel and pinion drive, so that mesh is maintained constantly whatever the position of the housings. The pinions transmit the drive to the rolls by means of intermediate pinion-trains housed in the swivelling brackets, the roll pinions being keyed on to the ends of the roll shafts. The drive is taken from a 175 h.p. electric motor, located in the rear housing, through totally-enclosed machine-cut helical gearing to the two crown wheels. All this gearing is enclosed in the rear housing, in which oil baths are formed for gear lubrication. An oil-circulating pump, driven off the input shaft, supplies an oil spray over the gears. All other lubrication points, on the ball and roller bearings, are fitted with grease nipples. The drive motor is of the variable-speed type, which enables pass speeds ranging from 75 ft. to 150 ft. per minute to be selected, according to the size and material of the tubes being straightened.

To prevent tubes with badly-bent ends from driving down between the rolls and stalling the machine, or otherwise becoming difficult to extract, a safety guide-bar is mounted on adjustable brackets fixed to the side frames. This guide-bar, which is only fitted as a safety precaution, and does not normally come into contact with the tubes, runs below the tube pass line. It is equipped with a range of shoes to suit the diameters of the tubes being straightened.

AUTOMATIC OPERATION

The tubes being of large size, and the straightening speeds being high, it is necessary to provide means of feeding and handling automatically. A set of mechanical inlet and outlet guides are therefore installed with the machine.

The entry conveyor is loaded with a tube selected by fingers from a stillage, and driven

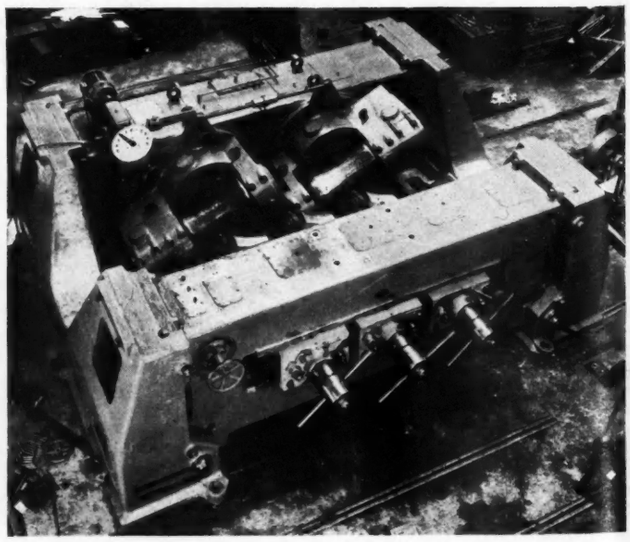

Fig. 2 The driving rolls at the rear are angularly adjustable, and the idle rolls at the front have both angular and linear adjustment. They can also be advanced and withdrawn to provide the straightening pressure.

rollers then advance the tube through the inlet trough. The rollers can be lowered when the tube has entered the machine. At the end of the inlet conveyor are two electrically-driven skew-rolls carried in housings which slide on a base-plate. These rolls grip the tube, rotate it, and deliver it to the machine rolls. When the tube has entered the machine the skew-rolls are released, the conveyor rolls are lowered, and the machine takes charge.

On the exit side of the machine the tube runs along an exit conveyor incorporating horizontal driven rolls and inclined pairs of idle rolls, which are adjustable to suit various sizes of tube, and which form a V-guide. The tube is removed from the exit conveyor by pneumatically-operated unloading arms. Both the entry and exit conveyors cater for a maximum length of tube of 44 ft.

All the controls are grouped at a central control point, where the operator has a clear view of the complete loading, straightening and unloading cycle and is, at the same time, well clear of the machine.

GRINDING WHEELS

METHODS OF MANUFACTURE FOR DIFFERENT SIZES AND QUALITIES

The Norton Grinding Wheel Company, Limited, Welwyn Garden City, Hertfordshire, is to undertake a £500,000 expansion programme to be completed in two years; the work will involve large-scale additions to the present factory together with the construction of new office buildings. This announcement, which coincided with the company's 25th anniversary, has recently been made by Mr. Milton P. Higgins, president of the parent Norton Company of Worcester, Mass. The new premises will not only house increased production facilities, but also enable a wider range of products to be manufactured, including refractory components for atomic energy applications. The grinding wheel, though familiar in most engineering works, is an item which tends to be taken for granted and consequently overlooked; we therefore take the opportunity in this article to outline the various processes in its production.

To-day the Norton Company makes an extensive range of grinding wheels both in specification and size, from $\frac{1}{4}$ in. in diameter and a fraction of an ounce in weight, to 72 in. across and weighing over 2 tons. These large segmented wheels may be 18 in. thick, while there are cut-off wheels only $\frac{1}{32}$ in. thick. Apart from straight wheels there are tapered, cupped and bevelled wheels designed for a variety of specialised tasks; and six or seven different abrasive materials may be used in their fabrication. Grit size is another variable, and there is also a choice of bonding agent. The number of processes involved is therefore considerable.

ABRASIVES

The first fabricated grinding wheels were made with such natural minerals as emery and corundum as abrasive. Although these consist mainly of aluminium oxide, which is still the most common abrasive used, their physical characteristics and chemical purity vary considerably, particularly with material obtained from different sources. Not only was it difficult to guarantee that wheels were identically repeated, but also the varying chemical properties led to serious problems in wheel manufacture.

To-day the basic materials are made electrically and their chemical and physical properties can be accurately controlled in accordance with specific requirements. Artificial, or synthetic abrasives of this kind include the Norton Company's "Alundum" or fused aluminium oxide (Al_2O_3) and "Crystolon" or silicon carbide (SiC). These two compounds are not made at the Welwyn Garden City factory since vast quantities of electricity are necessary for their production, but are brought from overseas plants, where cheap hydro-electric power is available.

The primary ingredients of Crystolon are coke, which supplies the carbon, and sand, which contains silicon. A mixture of sand, coke and sawdust is piled round a large carbon electrode running the length of a 20-ft. furnace and is walled up with uncemented firebrick. The sawdust is added to the mixture since a considerable volume of inflammable gas is evolved in the process and vents must be provided to permit the gas to escape. The sawdust makes the mixture porous so preventing explosions.

A very high current is passed through the electrode, producing a temperature as high as 2,320 deg. C. This causes a chemical reaction which results in the formation of silicon carbide. After cooling, the firebricks are removed and the outer crust of the furnace mixture removed to reveal a core of glistening silicon carbide crystals, which may weigh several tons.

For the preparation of Alundum the raw material is bauxite, a clay-like substance from which aluminium may also be extracted. It consists of hydrated aluminium oxide together with a number of impurities. The bauxite is mixed with a small amount of coke and iron filings, which act as reducing and purifying agents, and is then loaded into an electric arc furnace, open at the top. Two carbon electrodes are inserted into the open top and a very high current is passed between them to give a temperature of about 1,930 deg. C. As the bauxite melts, more and more is added until, at the end of the run, the furnace is filled with a large "pig" about 50 per cent. of which—at the centre—is Alundum.

The pigs of both abrasives are broken up by hammers into pieces convenient for handling and sent to the crushing plant. These are further reduced by jaw crushers and roll crushers to produce the range of grit sizes required. Ferrous impurities are removed by magnetic separators and other impurities by washing, after which the different grit sizes are first separated by accurately controlled mechanical screening. This gives the separate grit sizes up to a fineness of 240 mesh. Screening beyond this point is too difficult, so the further subdivision of finer sizes is usually carried out by "elutriation" (water settling) or by air flotation. The commonest grit sizes used are 14 to 60 mesh and "classified" grit sizes are available to a nominal fineness of 900 grit.

Screened abrasive is collected and handled in 100 lb. bags. In addition, the various types and grit sizes of abrasive are stored in large hoppers holding about 1,200 to 1,500 lb., with outlets—marked with the particular type of abrasive and grit—in the weighing department below.

BONDS

A further set of raw materials are those used to bind the abrasive grains together in the wheel shape or any other special form which may be required. The commonest bonds are: vitrified, resinoid and shellac. The vitrified bond consists of a mixture of clays and other minerals, which when heated to about 1,250 deg. C. fuses into a glassy material. The clay gives strength to the wheels when moulded and before firing, permitting them to be handled fairly readily.

The resinoid bond is used for wheels that are required to run at much higher speeds and to stand rougher treatment than a vitrified wheel would permit. It is essentially a thermosetting synthetic resin known as phenolformaldehyde. Thermosetting means that when heated (usually between 140 deg. C. and 200 deg. C.) the resin will cure to a hard, strong form which will not soften again on reheating. It is mixed as a powder, and other powdered materials may be added to facilitate manufacture, or to give special properties to the finished grinding wheel. A liquid plasticiser is used with a resinoid bond and this gives the necessary strength to the moulded product before curing.

Another bond which is used less frequently is shellac, which is a natural resin. This material is to some extent thermoplastic when cured, that is, it will soften slightly on reheating. This property can be useful in a few cases where the slight softening by the heat of grinding tends to give an improved finish.

WEIGHING AND MIXING

The manufacturing sequence comprises the following processes in the order given: weighing, mixing, pressing or moulding, shaving, kilning (for vitrified bonds) or curing (resinoid), truing, balancing and testing, and finally grading and inspection.

The required amount of abrasive—shown on an accompanying weighing card—is accurately weighed and placed in a hopper over a mixing machine of the right capacity. The abrasive may be composed of several grit sizes. It then passes to the mixing department where there are two types of mixing machine; a revolving-paddle machine of conventional dough-mixer pattern with twin horizontal paddles; and a revolving-pan machine, which is a refinement of the conventional concrete-mixer design.

The abrasive is emptied from the hopper above it into the mixing pan and the specified quantity of water and "temporary binder" is added while the mixer is in motion. The temporary binder is used to give extra strength to the "green" moulded product. An unfired or uncured product is always described as green. While this is being thoroughly dispersed throughout the abrasive grain, the correct amount of bond is weighed out and, then, with the machine running, is added slowly through a vibrating sieve to avoid any foreign matter entering the mix. When the mixing of the ingredients is complete, the mix is screened to eliminate lumps and covered with a damp cloth to avoid drying out. It is then ready for moulding.

The process for resinoid mixing is very similar to that used for vitrified products except that, instead of using water to moisten the mix, an organic liquid plasticiser, such as liquid resin or furfural, is introduced.

MOULDING

The moulding department houses presses of various sizes, some capable of exerting loads up to 2,000 tons or more. The mix is taken to the appropriate press and the correct mould equipment selected. The mould band or ring, bottom plate, and centre, each of which must be maintained to great accuracy, are assembled on a rotating table and the correct weight of mix accurately determined. This is then placed in the mould cavity, where it must be evenly distributed, and, while rotating, the surface is carefully levelled. The top plate is placed in position, the whole assembly slid under the press and the correct pressure applied. The steel centre and band are removed, followed by the top plate, and the wheel is ready for drying on the bottom plate. Alternatively, it is turned on to a flat "batt" or carrying plate for drying and the bottom plate removed.

Some products requiring very little pressure are moulded by compacting the mix on a vibrating table as this produces a greater uniformity in the very soft grades.

Abrasive sticks of square, circular, and other sections are extruded, and this requires a mixture which is more doughy and plastic than that used for moulding. Other products include delicate "mounted points" which are moulded by hand, and oilstones, which are moulded on screw presses.

Thin shellac cutting off wheels are made by a method reminiscent of pastry making. The mixture of abrasive and shellac is placed in a heated mould, which softens the shellac, and rolled with a heated rolling pin until compacted. The operator then inserts a broad knife-blade under the wheel and deftly flips it over back into the mould cavity and rolls it again to compact the

other side. Again using the knife-blade he flips the plastic wheel from the mould on to a cold steel plate which immediately chills it; after this it is hard enough to be handled safely for subsequent operations.

SHAVING

Until a vitrified wheel is burned it is relatively soft and friable, and easily shaped. Many wheels, such as cup wheels and saucers, are partly shaped before firing to avoid the more costly and wasteful shaping after firing. Small wheels can also be cut from large unfired moulded blanks. This is carried out on machines which are a variation and elaboration of the potter's wheel. In shaving a special shape, the moulded straight wheel is simply placed on the revolving table and centred to run true. A pen steel scraper blade of the required form is then fed down into the wheel, either by hand or mechanically, and the required approximate shape obtained very rapidly. The material scraped off can be recovered by washing the bond from the grain, and the abrasive used again.

All resinoid and shellac products are now ready for curing, but damp moulded vitrified products go to drying rooms where all added or " mechanical " water is driven off slowly.

KILNS AND CURING

In the kiln department where wheels with vitrified bonds are treated, the process is much the same as the firing of dishes, plates, and other pottery ware. It can, for example, be carried out in traditional " beehive " or periodic kilns—so called because of the repetitive cycle of setting, firing, and drawing. They may be either coal or oil fired, and one complete cycle may take from twelve days to almost three weeks according to the size of the kiln. Oil-fired tunnel kilns are also used. These are continuous in operation, and the correct firing cycle is determined by the rate of travel of the cars or carriers through the kiln. The time through the tunnel varies from four to nine days according to the kiln size.

For burning, the wheels are carried on batts embedded in a layer of clean sand and, provided that they are also separated by a sprinkling of sand to prevent sticking, the wheels may be stacked in piles. The usual firing temperatures are in the region of 1,250 deg. C. Accurate control of firing is maintained by means of thermocouples inserted at important points, while continuous readings and records are given by multipoint recorders.

In the case of resinoid bonds, many of the wheels are simply placed on batts for curing while others—particularly where a shape is to be maintained—may be surrounded by a coarse sand which prevents distortion while the bond is soft. The loaded batts are stacked on a carrier about 8 ft. square, allowing space for air circulation. This is then rolled into the oven. Curing temperatures may vary from 120 deg. C. to 200 deg. C. and the whole curing cycle completed in two days or less. After firing or curing the wheels are brushed free from sand.

Following this the wheels are taken to the truing department where the sides of the wheels are trued and machined down to size. This may be performed on lathes using conical steel cutters or on large machines which revolve the wheels under considerable pressure on a steel plate covered with loose steel shot. Some fine grit may be ground on the sides.

Holes are then reamed to the specified dimensions, or in some cases are bushed with lead. In this latter case the wheels are placed in a self-centring chuck with a spindle to give the required cavity. The molten lead is poured in through a gap in a cover plate, quickly set, and the " stringer " cut off by revolving the cover. The lead is then trimmed on a lathe with a conical cutter. Finally the face (periphery) may require truing or shaping. These operations are done either on a lathe with conical cutters, or by grinding.

From the truing department the wheels are conveyed to the balancing and testing department, where the wheels are first placed on balancing ways to make sure that they are within the limits of balance. Wheels outside this tolerance may sometimes be rectified by cutting a cavity in the periphery of the centre hole and filling this with lead.

The wheels then pass to the " speed testers " which ensure that any mechanical faults are brought to light. The wheel under test is completely enclosed in a strong steel casing; and the wheel speed is shown by a tachometer driven from the machine spindle. Wheels are tested to 50 per cent. above their intended operating speed, giving a safety factor of over 200 per cent.

The last stage is grading and inspection. To ensure that each wheel conforms with the specification given on the check card which accompanies the wheel on its route through the factory, the wheel is inspected for dimensions, general appearance, abrasive and grit size; and in addition the grade or hardness of sample wheels is investigated by means of penetration tests. A final check for size and defects completes the inspection.

HARD COMPOUND AND POROUS MEDIA

In addition to the compounds already described, the Norton company makes boron carbide —" Norbide "—believed to be the hardest material produced commercially. It is used for lapping abrasive, as a metallurgical compound and for abrasion-resisting moulded products. Other products include diamond wheels, hones, oilstones, abrasive paper and cloth, heavy-duty refractories, and porous media for filtration and diffusion.

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TWO-STAGE CATHODIC PROTECTION

Application to Oil Tanker

Cathodic protection was applied in two stages to the oil tanker compartments of M.S. Regent Springbok by Metal and Pipeline Endurance Limited, 22 Queen Anne's-gate, London, S.W.1.

Cathodic protection of steel in seawater poses a problem in that current requirements have been found to change rapidly with time after the application of a protective current. If current densities sufficiently high to effect immediate protection are applied, in a short time it will be found that the applied current is greatly in excess of the current actually required for protection. On the other hand, if current densities of the order of those required after equilibrium is established are applied initially, it is found that as much as several years may elapse before complete control of corrosion is obtained.

Thus initial polarisation and building up of a calcareous film may either be carried out by the installation of magnesium anodes with a large area/weight ratio or by current supplied from generators during the docking period when there is no fire hazard. So far as is known the M.S. Regent Springbok was the first example of a cathodic protection installation using generators and temporary anodes to supply the initial high current density.

Magnesium anodes, shown in the accompanying illustration, each weighing 200 lb. and with an estimated life of four years, were installed in the empty tanks of the M.S. Regent Springbok after they had been certified free of gas. Temporary steel anodes were then installed and the tanks were completely filled with seawater. Current was supplied by direct current generators mounted on deck. In this way the 30 tanks were completely polarised, partially descaled and fitted with a permanent cathodic protection installation during the vessel's special survey period of 17 days.

As in any comparable cell, hydrogen was generated during the polarisation process, and to avoid any possible fire hazard stand pipes were installed on the deck to route the gas away to atmosphere. The generators installed on the deck caused no interference with the normal maintenance programme and the whole project involving 30 tanks was completed before sailing date with a cathodic protection system requiring no anode renewal for 4 years.

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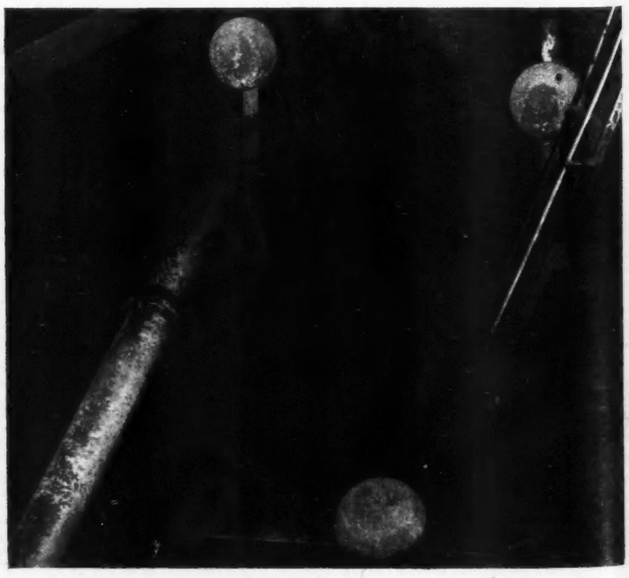
MECHANICAL HANDLING FILM

A Prelude to the 1956 Exhibition

A 16 mm. 30 minute colour film entitled " Mechanical Handling on Show " has recently been shown for the first time. Using as its location mechanical handling exhibitions of previous years, it provides an interesting documentary record of modern handling devices from truck-tipping equipment, and a radio-controlled overhead crane to bottle-crating machines and an integral tail-board loader for motor trucks. Vibrating, screw, gravity, roller, belt, slat, pneumatic-tube and portable conveyors are shown, together with a wide range of fork trucks. Clear bright colour and a lucid commentary add to the value of the film, which is slightly marred by the overwhelming mass of material which has been included. Copies may be obtained on loan from " Mechanical Handling," Dorset House, Stamford-street, London, S.E.1. The film serves as a prelude to the 1956 Mechanical Handling Exhibition, which will be held at Earl's Court from May 9 to May 19.



Magnesium anodes weighing 200 lb. and with an estimated life of four years in the oil tanks of M.S. Regent Springbok. High current densities are applied through temporary steel anodes to effect initial polarisation and build up calcareous film.

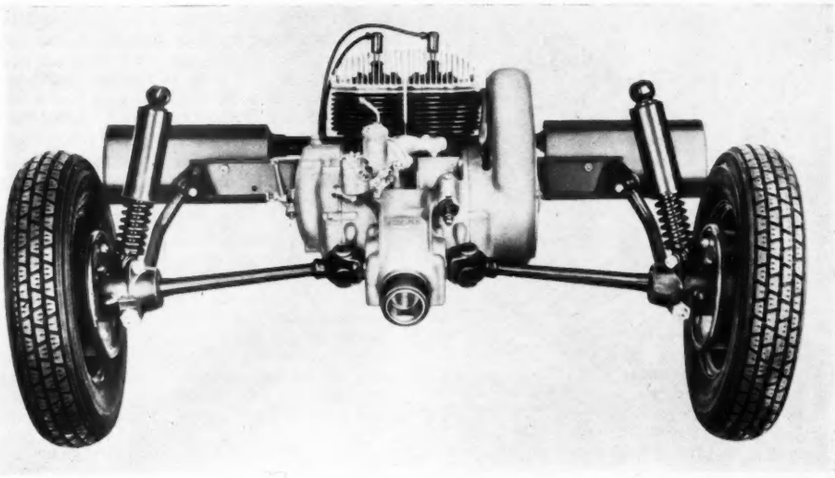


Fig. 14 Rear engine, transmission and suspension unit of the Goggomobil miniature car, showing how the drive shaft is used to form one arm of the suspension wishbone.

The Motor Show at Earl's Court, London (October 19 to 29) *(continued from page 580)*

MOTOR CAR DESIGN

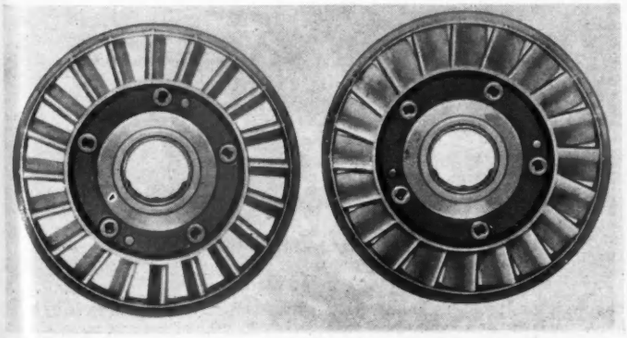
CURRENT TRENDS AND PRACTICES: 2—TRANSMISSION AND SUSPENSION

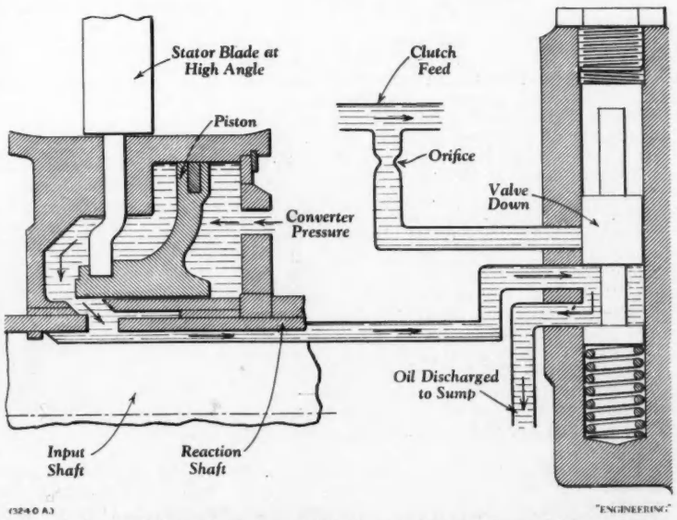
There have been no great developments in automatic transmissions this year, but there are now two designs of American origin available to British manufacturers: the Rolls-Royce made under Hydramatic patents and the Borg Warner with a torque converter, planetary gear set and direct-drive locking clutch. Daimler have been preparing for production of the British Hobbs automatic four-speed planetary transmission, which will be offered to other manufacturers, and have employed the interval on development work, particularly with the object of securing quieter running. In the United States, the Hydramatic, consisting of fluid coupling and four-speed epicyclic gearbox, is used by Cadillac, Oldsmobile, Pontiac, the six-cylinder Nash and Hudson models, the Rambler and the Willys. The Powerflite, used by the whole Chrysler group, and the Powerglide, used by Chevrolet, consist of torque converter with two-speed epicyclic gear set, starting in low and shifting automatically to direct drive. Ford, Mercury, and Lincoln now use a torque converter with three-speed planetary set which normally starts in second; a kick down on the accelerator produces a shift to first, and either first or second can be used for downhill braking. Studebaker use the Borg Warner, giving a similar arrangement, with the addition of a clutch to lock the converter for direct drive. A lock for the converter also figures on the Ultramatic used by Packard and on the eight-cylinder Nash and Hudson models.

Engines are designed to give their maximum torque in the range from 2,500 to 3,000 r.p.m. and never have to pull hard at low speeds. Advantage has thus been taken of the high-grade fuels available to use very high compression ratios in the interests of fuel economy. Some of the 1956 engines soon to be announced will have compression ratios of 10 to 1 and quoted powers represent specific outputs of about 48 b.h.p. per litre. These are, however, test-bed figures.

BUICK TORQUE CONVERTER

An interesting innovation has been the use of variable-pitch two-position stators in the Buick Dynaflow torque converter, which is illustrated in Figs. 15 and 16, below. The circuit consists of a pump, two turbines and stator. A two-speed planetary gear set intervenes between first and second turbines, and the stator is carried on a roller-type free wheel. The stator has 20 blades, each with an operating crank on an annular carrier. Inside the carrier is an annular piston which moves axially, swinging the operating cranks under the action of oil pressure. A two-position control valve is linked to the accelerator pedal, and when the pedal is fully depressed the stator blades swing to a high angle of attack, increasing the stalling speed, and raising the maximum torque multiplication from 2·1 to 2·5 to 1. When the low range is engaged, with planetary reduction gear in operation, the stator blades are held at the high angle regardless of accelerator position. In this condition an overall torque multiplication of 4·55 to 1 is available when starting from rest.





Figs. 15 and 16 The Buick torque converter incorporates variable-pitch stators. A two-position valve connected to the accelerator gives a high angle at full throttle. Fig. 16 shows the control mechanism in the high-angle position.

France has taken important steps towards easier driving on small economy cars with the centrifugal clutch on the 2 CV Citroen, and the Ferlec electromagnetic clutch on the 4CV Renault. With the former, a normal clutch has to be used for gear changing, but the Ferlec, described in ENGINEERING for November 5, 1954, page 610, eliminates the clutch pedal, the clutch being freed as soon as the weight of a hand is felt on the gear lever.

A similar result is obtained by the Manumatic clutch control, now adopted in Britain by Armstrong Siddeley for the new 2·3-litre six-cylinder car. The unit has been improved in many respects since the first version was demonstrated in 1952. It consists of a special clutch engaged by centrifugal action for starts from rest, a built-in synchronising switch, a vacuum-operated clutch servo, a vacuum reserve tank, and a control unit comprising servos which open and close the throttle during gear changing under the action of solenoids. The two throttle control units are independent of each other and of the accelerator pedal. One operates in conjunction with the clutch servo piston and the other is controlled by a synchronising switch built into the clutch. During gear changing, a switch on the gear lever actuates the valve controlling the clutch withdrawal piston. Automatic increase or reduction of engine speed is effected by the synchroniser switch before the clutch can re-engage. All the driver has to do is move the gear lever and maintain a steady pressure on the accelerator pedal. Some care has to be taken in installation and adjustment and this may so far have stood in the way of the adoption of this system on small cars produced in large numbers.

Independent front suspension is now standard practice, and with the non-appearance of the A.C. saloon at the London Show, the only car with non-independent suspension on view has been the Ford Popular. Independent rear suspension is, however, still far from finalised and a great deal of development work is being done on the Continent. A rear engine naturally makes independent suspension necessary, but manufacturers of front-engined cars adopt it to reduce unsprung weight, and to obtain improved traction by relieving the wheels of transverse drive torque reactions. The single-

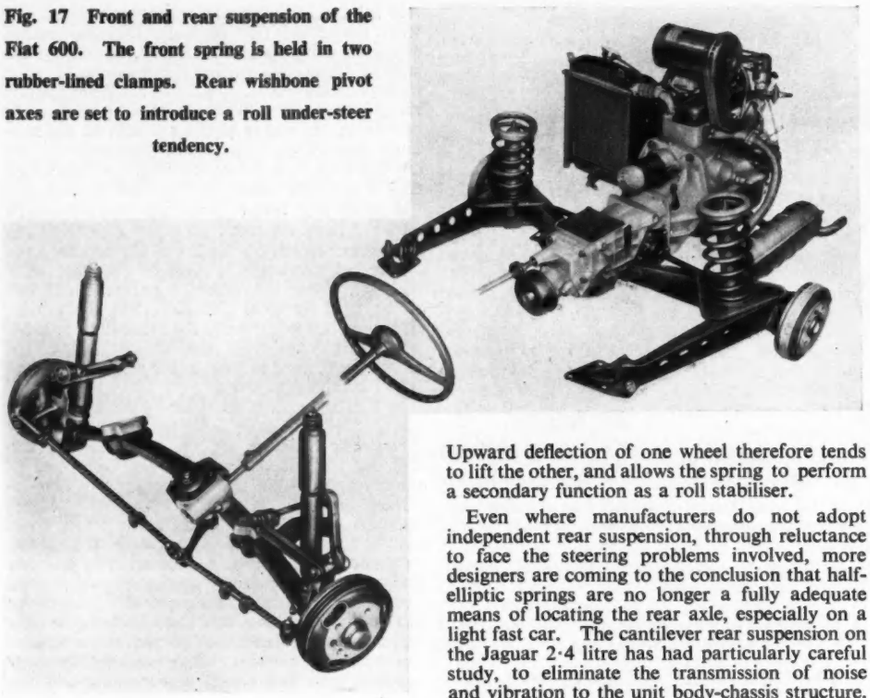


Fig. 17 Front and rear suspension of the Fiat 600. The front spring is held in two rubber-lined clamps. Rear wishbone pivot axes are set to introduce a roll under-steer tendency.

pivot swing axle with a low roll centre introduced on the Mercedes 220 is now used also on the 300 models. In this layout, the differential housing swings with one of the half axles, which is therefore subject to torque reaction, and the results obtained, although good, do not suggest that finality has been achieved. It was described in last year's Motor Show articles.

GOGGOMOBIL UNIT

A very simple arrangement, illustrated in Fig. 14, sometimes proposed but not previously seen in production, is used on the little Goggomobil, a rear-engined economy car now being built at the rate of 60 a day near Münich. The twin-cylinder 293 c.c. fan-cooled two-stroke engine is in unit with the gearbox at the rear, and the drive shafts each form one arm of a suspension wishbone. The remaining arm, attached to the hub, projects rearwards to an anchorage on the frame. Cornering thrust is taken through the universal joint, and via a flange on the drive shaft to a thrust ring in the transmission housing.

The Fiat 600 uses single wishbones of more conventional conception, lying ahead of the transmission shafts, and with pivots at an angle of 74 deg. to them. The arrangement is shown in Fig. 17, above. The rear wheel toes in as the spring is compressed, and roll introduces an under-steer geometry to counteract the over-steering tendencies produced by the concentration of weight on the rear wheels. With only two people in the car, 57 per cent. of the weight is on the rear, and rear tyres are run at a pressure 33 per cent. higher than those in front. The steering effect works admirably on corners, and the car handles extremely well on winding roads. On the other hand, if a sudden swerve becomes necessary when travelling fast on the straight, the corrective effect of the roll under-steer does not develop strongly enough, and pronounced over-steer results. The outer end of each drive shaft is splined to a star-shaped bonded-rubber coupling, the outer shell of which is attached to the wheel spindle—one of the many points where rubber is used in the road gear of this car for damping out noise and vibration.

Front suspension of the Fiat employs an arrangement used on some sports cars but not previously seen on touring cars. The transverse leaf spring is secured to the frame by two rubber-lined clamps, and is free to flex in the middle. Upward deflection of one wheel therefore tends to lift the other, and allows the spring to perform a secondary function as a roll stabiliser.

Even where manufacturers do not adopt independent rear suspension, through reluctance to face the steering problems involved, more designers are coming to the conclusion that half-elliptic springs are no longer a fully adequate means of locating the rear axle, especially on a light fast car. The cantilever rear suspension on the Jaguar 2·4 litre has had particularly careful study, to eliminate the transmission of noise and vibration to the unit body-chassis structure. Rubber is used extensively to give the axle a calculated degree of flexibility about its centre. Rubber bushes are used at the ends of the two radius arms, at the attachment points on the rear ends of the springs, and at the anchorages for the transverse Panhard rod. The spring itself is attached to the structure by a rubber-lined clamp which permits a slight degree of fore and aft movement, and the forward end of the spring bears on a rubber pad. As there are no spring attachments behind the axle, the whole tail of the car is free to accommodate luggage boot, fuel tank and spare wheel.

Alfa Romeo use exceptionally flexible coil springs on the Giulietta saloon and sports coupé and locate the rear axle by radius arms and a triangular central linkage, attached to a ball joint at one side of the differential casing as shown in Fig. 18. Numerous variations of this centre linkage, which allows the designer to place his roll centre precisely, are found on such fast cars as Maserati, B.M.W., Bristol and Frazer Nash.

A feature which seems to be gaining support is the interconnection of front and rear suspension to reduce pitching. It was seen some time ago on the 2CV Citroen, and is employed on the Allison torsion bar system (Fig. 19) adopted by Packard in the United States. The Citroen system originally consisted of two coil springs in compression, connected to the wheel arms by rods, and carried in a tubular housing on the chassis frame, the whole housing being free to move fore and aft but restrained by two volute springs. The layout has now been simplified. There are two coil springs in tension, connected together by a short steel tie and restrained in their fore and aft movement by rubber buffers bearing against stops on the chassis frame.

In the Packard system, illustrated in Fig. 19, below, front and rear wheels are connected to opposite ends of two torsion bars 9 ft. long. Thus, as a front wheel strikes a bump, the rear of the car is lifted at that side, giving a level ride. There are also short auxiliary torsion bars at the rear, which can be loaded by levers worked by an electric motor. These compensate automatically for varying loads, keeping the rear of the car at a constant level. When an extra load is imposed, the electric motor loads the torsion bars, raising the car to the normal static position, and when the load is removed, causing the back of the car to rise, the bars are again adjusted to restore the level. A time lag is introduced so that the suspension is not continuously trying to adjust itself to road inequalities. For some reason the electric motor has not been wired through the ignition switch, and parked cars provide an entertaining slow motion see-saw for small boys, with a consequent drain on the battery.

The use of ball joints on the ends of front suspension wishbones to eliminate separate steering pivots was pioneered by European constructors like Citroen and Jaguar, but General Motors have now found a way to exploit them to reduce nose-diving through weight transference when the brakes are applied. As can be seen from Fig. 21, the axes of the wishbone pivots converge towards the rear, and when the

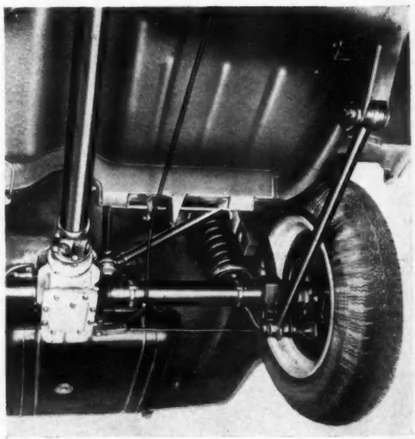


Fig. 18 Rear suspension of the Alfa Giulietta, showing radius arms and central linkage connected to a ball joint on the differential casing.

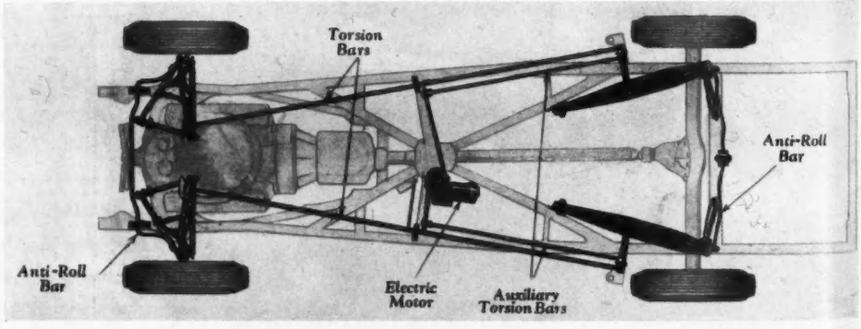


Fig. 19 The Allison suspension system adopted by Packard interconnects front and rear wheels by long torsion bars to eliminate pitching. A bump at a front wheel tends to lift the rear of the car, maintaining a level ride. Shorter torsion bars on each side are automatically loaded by levers operated by an electric motor to keep the car at designed static height regardless of load variations. Rear-axle thrust and brake torque are taken through two converging radius arms, and there is a transverse anti-roll bar.

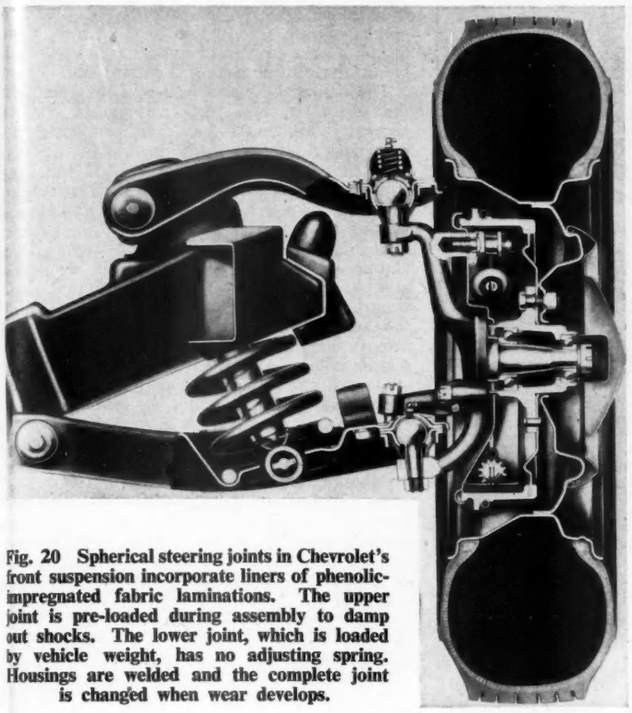


Fig. 20 Spherical steering joints in Chevrolet's front suspension incorporate liners of phenolic-impregnated fabric laminations. The upper joint is pre-loaded during assembly to damp out shocks. The lower joint, which is loaded by vehicle weight, has no adjusting spring. Housings are welded and the complete joint is changed when wear develops.

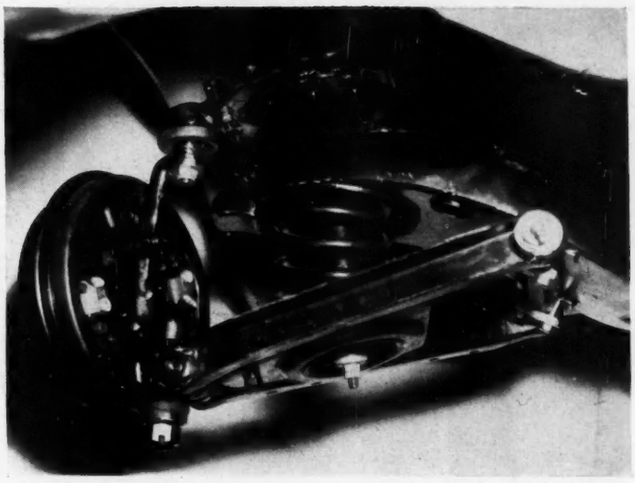


Fig. 22 The Sunbeam Rapier front suspension has a ball joint at the top and pivot pin at the lower end working in a trunnion on the lower wishbone. A similar layout has now been adopted by Standard for the new Vanguard III.

front springs are compressed, the top of the king-pin moves rearwards. This action is reversible, and brake torque tends to twist the king-pin the other way, thus resisting upward movement of the king-pin and reducing the nose-diving tendency.

The Chevrolet ball joints (Fig. 20) have welded housings and are non-adjustable. They are lined with phenolic-impregnated fabric laminations, and the upper joint is pre-loaded during assembly to damp out road shocks.

Both the Sunbeam Rapier and the latest Standard Vanguard have adopted a ball joint for the top pivot, and a normal pivot pin for the lower ends, carried in a trunnion on the lower wishbone. The Sunbeam assembly, illustrated in Fig. 22, uses a full ball in a two-piece housing. Both this and the Standard front suspension are assembled on detachable cross members. The former is secured to the body structure by rubber cushions, but these were abandoned as unnecessary after preliminary trials on the Standard Vanguard III and the cross member is now secured by four metal-to-metal joints, two being conical to take the car weight, and two at the front being transverse pin joints to take brake torque.

The Jaguar also employs a detachable cross member, on which both suspension linkages and steering gearbox are mounted. The weight here is taken on two rubber V-blocks, and two forward-projecting torque arms terminate in rubber shear pads to absorb torque loads.

Despite the experience which has been gained in the design of such attachments, a certain amount of experimental work is still needed in evolving the best combination to suit the requirements of noise suppression in a new unitary car structure.

To be continued

* * *

EDUCATING YOUNG WORKERS

Oxford Conference in April

Under the patronage of H.R.H. the Duke of Edinburgh, the Department of Education of the University of Oxford has organised a further conference on "The Education of the Young Worker." It is the sixth of the series and is intended to bring together officers of local education authorities, teachers in secondary schools and further-education colleges, officials of voluntary organisations, employers, managers, trade-unionists, and others interested in studying the educational needs of young people engaged in industrial employment.

In particular, the delegates will consider the needs of young workers preparing for relatively unskilled occupations, such as those who leave school at 15 years of age to take up employment in agriculture, transport, factories, mines, shops and offices, and whose brief training offers few opportunities for intellectual and personal development. Groups of delegates will be formed for the study of these problems, each group being representative of varied industrial and educational interests. They will hold discussions two or three times daily and will meet at a plenary session for the summary of their conclusions. Lectures will be provided on various aspects of the subject, including "The Cotton Industry," by Mr. G. Fielding, C.B.E., "The Chemical Industry," by Mr. H. A. Collinson, F.R.I.C., "The Distributive Trades," by Miss Evelyn Gibbs, and "On Voluntary Work with Young People," by Mr. Edwin Barker, M.B.E., M.Sc.

The conference will be held at Oriel College, Oxford, from Saturday, April 7, to Friday, April 13, 1956. Accommodation will be provided at the College, in which all lectures and discussions will take place, and the inclusive fee will be £12. A few non-resident members will be accepted at a fee of four guineas. A report on the resolutions and conclusions of the conference will be published at a later date. Further information and reports of previous conferences, price 10*s.* a set post free, may be obtained from the secretary, the Young Worker Conference, 15 Norham-gardens, Oxford.

* * *

COAL UNDER THE SEA

Seam Struck by Off-Shore Boring Unit

The National Coal Board's off-shore boring unit has struck a seam of coal at a depth of 2,000 ft. below the bed of the Firth of Forth after five months drilling. The unit, which was described in ENGINEERING for May 27, 1955 (vol. 179, page 674), was towed to a position about a mile off Kirkcaldy and moored there on May 22. The coal has been found at a deeper level than was expected, and it may be necessary to replan the roads to be driven four miles under the sea from Seafield colliery. The coalfield to be worked by Seafield, the sinking of which was inaugurated in 1954, is one of the richest in coal density in the country, and the output is expected to be 5,000 tons per day.

The borer will probably be moved within the next few months to a new drilling position about 1½ miles from the present site and three miles off-shore. Undersea extensions of coalfields form important reserves in East Scotland, Durham, and Northumberland; after their initial success it seems likely that the Coal Board will use this or similar towers for drilling in other parts of Great Britain.

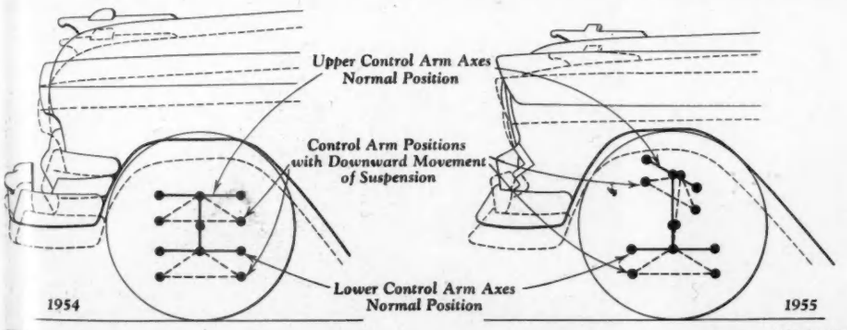
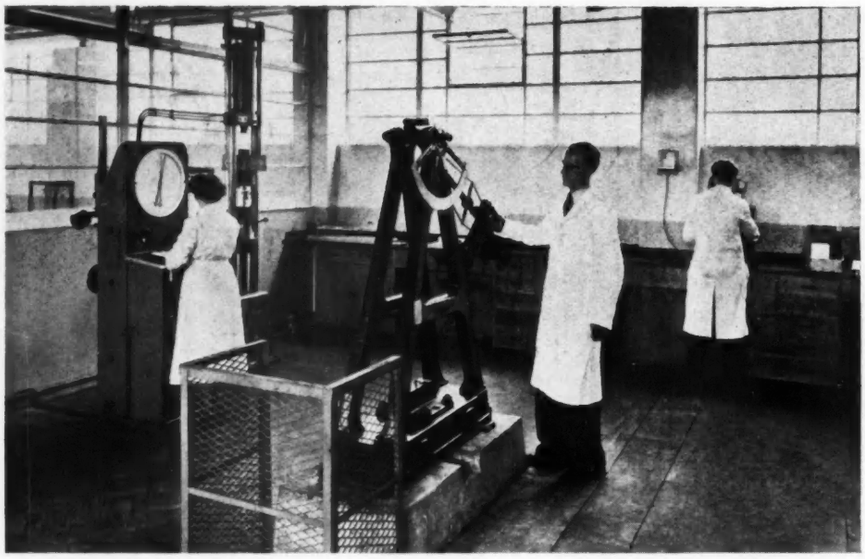


Fig. 21 Use of ball-joint steering pivots has made possible Chevrolet's improved front-suspension geometry, which reduces nose-diving caused by transfer of weight on to front wheels when braking. By sloping the pivots of the upper wishbones towards the rear, the king-pin is given a backward inclination when the front springs are compressed. Brake torque tends to twist the king-pin in the opposite direction, thus resisting suspension deflection and reducing the diving tendency.



In the new laboratory of Garringtons, Limited, Bromsgrove, routine mechanical tests are carried out on samples of every cast of steel received.

QUALITY CONTROL OF STAMPINGS AND FORGINGS

NEW LABORATORY FOR GARRINGTONS

Garringtons, Limited, a member of the Guest, Keen and Nettlefolds Group of Companies, have increased their output of stampings and forgings thirty-seven fold since 1939, and now produce about 100 million components a year. A very large proportion of the output is obtained from the Company's Newton Works, Bromsgrove, Worcestershire, which commenced operation in 1946.

Newton Works were provided from the beginning with laboratory facilities, but the need for metallurgical control over both raw materials and finished products has grown with the increased variety of material specifications handled, and the exacting requirements of customers. Accordingly, a new laboratory has been provided which was officially opened on October 11, by Dr. T. Emmerson, director of research at the G. K. N. Group Laboratories, Lanesfield, Wolverhampton.

The new laboratory is housed in a two-storey brick building, with a total floor space of 6,000 sq. ft. The mechanical testing and chemical analysis departments are located on the ground floor, and facilities for metallography, photography, pyrometry and experimental heat treatment are provided on the upper floor. A service elevator is installed for the transport of samples between the two floors. Lighting, both natural and artificial, and ventilation are of a high standard throughout, and the working conditions generally are attractive.

TEST AND ANALYSIS

A sample of every cast of steel and non-ferrous alloy received at the works is tested for hardness, tensile strength, ductility and impact value. Machines for cutting, grinding, drilling and milling test pieces are provided near to the testing equipment. Three machines are available for tensile testing: a 50 ton Avery; a 20 ton Amsler; and a Hounsfield Tensometer. Impact values are determined on an Avery Izod machine, and hardness testing is carried out on an Olsen Brinell machine. Wild Barfield muffle hardening and tempering furnaces, complete with quenching equipment, are installed for heat treatment of the test pieces. In the case of steel samples a Spekker Steeloscope is used for spectrographic examination of the sample for a broad check on the composition of the steel before the routine testing is carried out.

The chemical laboratory is well equipped with the usual benches, fume cupboards and all necessary apparatus for rapid and accurate analysis. A sample from each cast of steel received is completely analysed, and this constitutes the bulk of the work of the department. There is, however, a wide range of other materials passing through the works. The Gas Turbine Division, in particular, uses aluminium alloys, aluminium bronzes, stainless steels, Nimonic, and titanium alloys, and analyses of these materials are undertaken regularly. In addition, the composition of die and tool steels is checked as a routine matter, and the pickling and electroplating solutions used in the hand-tool section of the works are under daily control. The equipment in use includes a Spekker photo-electric absorptiometer, a Strohlein apparatus for the rapid determination of carbon in steel, and a double-unit electro-chemical apparatus for the analysis of non-ferrous alloys.

Specimens for microscopic examination are prepared by rough grinding on a Union pedestal grinding machine or an Excel surface grinder, followed by grinding on a linisher, and hand grinding on emery papers. The final polishing to a mirror finish is done on four Jackson rotary-disc machines. Small micro-sections can be mounted in Bakelite on Nash and Thompson and Apex presses.

Microscopic examination can be carried out on a Vickers projection microscope, two Cooke, Troughton and Simms binocular bench microscopes, or a Watson projection microscope. A Beck binocular magnifier is used for low-power examinations. Photo-micrography can be carried out on either the Vickers or the Watson projection microscopes. A Kodak laboratory camera and a Blumfield enlarger are available for technical photography, and there is a large dark-room with all necessary equipment.

The metallography department conducts routine examinations of steels and non-ferrous alloys as received, and and does similar work on forgings and other products of Newton Works. Non-destructive testing is also undertaken in this department, the equipment available including a Fel-Electric crack-detector, G.E.C. magnetic sorting bridges, and Vickers Pyramid, Rockwell and Firth Hardometer hardness testing machines.

EXPERIMENTAL HEAT TREATMENT

Adjoining the metallography department is a section equipped for experimental heat treatment, of which a considerable amount is done. The equipment includes a Wild Barfield horizontal muffle furnace, which can be used for hardening, annealing, normalising and carburising, and a Wild Barfield forced air circulation furnace for tempering. An I.C.I. gas-fired salt-bath furnace is also installed. High-temperature heat treat-

A section of the laboratory is responsible for supervising the pyrometers used throughout the factory.

A range of furnaces and quenching equipment enables experimental heat treatment to be undertaken.

ment is carried out in a Johnson Matthey platinum-wound tube-furnace, which has a maximum working temperature of 1,400 deg. C. Oil and water quench-tanks are provided, and there are quenching fixtures on the latter for Jominy and Rockwell Inch hardenability tests. A hot-water wash-tank serves to clean the test pieces after heat treatment.

A separate room in the laboratory houses the pyrometry department, which is responsible for supervising temperature-control on all the furnaces used in the works. Operators in this section standardise and maintain in working order all the pyrometers in use, and patrol inspectors attached to the department carry out regular checks of operating temperatures at the furnaces by means of optical pyrometers. The equipment installed in the pyrometry department includes Cambridge and Foster potentiometers, and a Wild Barfield crucible furnace for the standardisation of thermocouples.

* * *

THERMOSTAT FOR CONTROLLING ROOM HEATING

An addition to the range of thermostats made by Cyril Kieft and Company, Limited, 13 Dudley-road, Wolverhampton, is illustrated on the right. It is designed for the temperature control of rooms or offices which are electrically heated. It operates from a bi-metal strip controlling a micro-switch of the makers' own design and is capable of switching loads up to 15 amperes on alternating current up to 250 volts. With direct current the thermostat is suitable for relay circuits only. A cover of modern design encloses the complete thermostat, leaving only the setting knob, temperature scale and neon indicator lamp visible. A choice of temperature ranges, 30 to 90 deg. F. or 5 to 25 deg. C. is available, and the operating differential is normally set at 2 deg. F. Other differentials are available. Cable entry is through the rear for concealed wiring and through "knock-outs" for wall installation. A rubber grommet is provided in the base of the thermostat for cable entry at this point if required. A cartridge fuse is fitted internally.

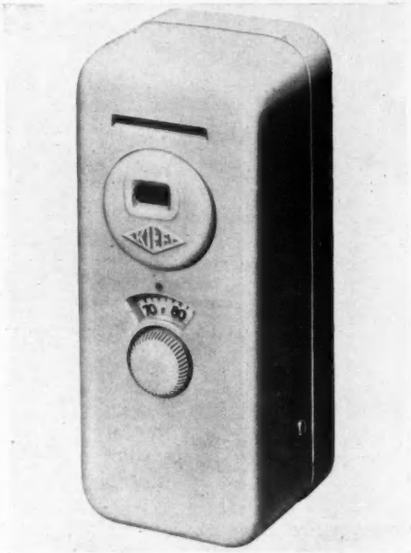
* * *

AIR REDUCING VALVES FOR AIRCRAFT

Pressure Control of Engine-Tapped Air

A new series of hot air reducing valves for aircraft has recently been added to the range made by the Hymatic Engineering Company, Limited, Redditch, Worcestershire, designed to control hot air tapped from a gas turbine compressor. Known as the PS.60 series, the valves can stabilise inlet pressures of up to 160 lb. per square inch at constant adjustable outlet pressures of up to 35 lb. per square inch within temperature limits of − 40 deg. C. to 300 deg. C. This wide operating range is achieved by the use of light alloy—the valves weigh only 0·75 lb. each—and by the exclusion of any organic packing materials.

The PS.60 series of reducing valves will control air between − 40 deg. and + 300 deg. C.



The Kieft thermostat has an operating differential of 2 deg. and will switch up to 15 amperes on 250 volt alternating current.

There are various types of reducing valve in the PS.60 series. One is designed to control the outlet pressure in relation to the ambient or other datum pressure; another to control the outlet pressure in relation to absolute pressure; most types may be fitted with an integral relief valve as is the one illustrated.

Since no packing is used, a slight leak is unavoidable, and so a vent connection, which also acts as a datum pressure connection on the first type of valve, is provided to pipe the leakage air away.

Both types contain simple but highly effective mechanisms for balance and compensation which ensure that the outlet pressure is almost unaffected by variations in inlet pressures, and that a close control can be maintained over a wide range of flows. The outlet pressure can be held within plus or minus ½ lb. per square inch for flows up to 10 cub. ft. of free air per minute.

The PS.60 series valves are suitable for duties where contamination with gas turbine fuels is likely, as the casing is pressure tight. There is no risk, therefore, of fuel leakage into the surrounding aircraft structure.

Supplies of air controlled by these valves can be used for: fuel tank pressurisation to transfer or jettison fuel, or to prevent fuel loss caused by boiling at high altitudes; fuel recuperator pressurisation; supply to airborne missiles; pressurising and cooling or heating electronic equipment; ventilated suit installations; anti-*g* installations; hydraulic header tank pressurisation and space and component heating and ventilation.

* ✲ *

ELECTRIC HAULAGE CAPSTAN

Developed primarily for the haulage of wagons, as an alternative to a locomotive, the Lo-bed electric capstan is another addition to the equipment made by the Taylor Stoker Company, Limited, 189/191 Drummond-street, London, N.W.1. A typical installation, with local push-button control, is shown in the illustration on the right.

The capstan is fully weatherproof, and is driven by a 5h.p. squirrel-cage motor running at 1,500 r.p.m. This motor has a high starting torque, is 30 minute rated, and is arranged for direct-on starting from a separate starter. The drive is taken through a reduction gearbox in which a steel pinion and spur wheel drive a steel worm and bronze wormwheel which is mounted on the vertical barrel shaft. The main shaft is mounted in ball and roller journal and thrust bearings while the barrel shaft runs in bronze bushes. The entire gearing is totally enclosed and runs in a oil bath.

The barrel is of close-grain cast-iron and being mounted vertically, can take the rope at any horizontal angle. A maximum starting pull of 5,000lb. can be developed and a rope speed of 45ft. per minute can be reached when the load is on the move. Reckoning a pull of about 30 to 35lb. for each ton of load, means that trains of wagons of more than 100 tons can be moved on level track. For curves or gradients the amount is proportionately less. The fact that the rope is not limited to a single direction allows one capstan to serve several lines. It is a very compact unit as the overall dimensions are only 1 ft. 9 in. wide by 2 ft. 6 in. long and 2 ft. 2 in. high. It weighs approximately 5 cwt. Apart from the movement of wagons, the capstan can, of course, be used for any purpose for which haulage is required.

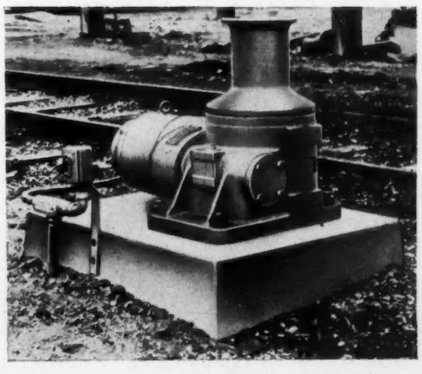
* * *

GLASS CLADDING FOR BUILDINGS

Permanently Coloured & Stable

A new cladding material—Muroglass—for framed building structures has been introduced by Pilkington Brothers, Limited, St. Helens, Lancashire. The glass it is claimed, offers durability, variety of colour, stability, and a pleasing appearance. The surface, impervious to atmospheric attack, non-porous, non-absorbent, and self-cleaning, is lightly textured to prevent hard reflections. Its thickness is ¼ in., the same as plate glass in shop windows and rough-cast glass for factory roofing. Under sustained stress the strength of Muroglass is 1,000/1,250 lb. per sq. in. but under momentary stress it rises to between 2,000/2,500 lb. per sq. in. It is available with or without wire mesh embedded, the virtue of the wired variety being that, if broken, the pieces are held together and cannot fall from the framework. It is offered in six permanent colours: red, green, light blue, dark blue, grey and yellow. To this range light green and pink will soon be added. The supply of special colours for quantities of not less than 10,000 sq. ft. would depend upon the availability of a satisfactory opaque coloured enamel which would fuse with the basic glass. It is fixed by employing any of the standard glazing techniques.

The width of the glass as rolled is 48 in., and standard sizes are in 24 in. and 48 in. widths in lengths up to 100 ft. Other widths and lengths greater than 100 in. can be supplied.



With a maximum pull of 5,000 lb., the Lo-bed electric capstan can haul wagons totalling over 100 tons on the level. The vertical barrel allows great freedom for handling the haulage rope.

FORTHCOMING EXHIBITIONS AND CONFERENCES

This list, arranged chronologically, appears in the last issue of each month. Events appearing for the first time, and alterations of dates, places, etc., are indicated by an asterisk (*). Particulars of exhibitions and conferences not included below may have appeared in ENGINEERING, *August* 26, *page* 287; *or September* 30, *page* 478. *Organisers are invited to send to the Editor particulars of coming events as soon as arrangements are made.*

***Dividing Engines, Exhibition of.**—Sat., Oct. 1, for about six months, at the Science Museum, South Kensington, London, S.W.7. Apply to the director of the museum. Tel. KENsington 6371.

Indian Industries Exhibition.—Sat., Oct. 29, to Thurs., Dec. 15, in Delhi. *Agents:* Auger and Turner Group Ltd., 40 Gerrard-street, London, W.1. Tel. GERrard 6671.

Belfast Business Efficiency Exhibition.—Mon., Oct. 31, to Sat., Nov. 5, at King's Hall, Belfast. Organised by the Office Appliance and Business Equipment Trades Association, 11-13 Dowgate-hill, London, E.C.4. Tel. CENtral 7771.

Impact of Science on Management in the Future, Conference.—Wed., Nov. 2, to Fri., Nov. 4, at Harrogate. Organised by the British Institute of Management, 8 Hill-street, London, W.1. Tel. GROsvenor 6000. See ENGINEERING, August 26, page 283.

***Institute of Welding, Autumn Meeting.**—Thurs. and Fri., Nov. 3 and 4, at Institution of Civil Engineers, Great George-street, London, S.W.1. Annual Dinner, Park Lane Hotel, Piccadilly, London, W.1., Wed., Nov. 2. Apply to the Institute of Welding, 2 Buckingham Palace-gardens, London, S.W.1. Tel. SLOane 9851.

Protective Equipment Conference.—Fri., Nov. 4, at the London School of Hygiene and Tropical Medicine, Keppel-street, London, W.C.1. Organised by the British Occupational Hygiene Society. Apply to Mr. D. Turner, Medical Research Council Laboratories, Holly-hill, London, N.W.3. See ENGINEERING, August 19, page 253.

Work Study Conference.—Fri. and Sat., Nov. 4 and 5, at St. Ermin's Hotel, Caxton-street, London, S.W.1, on "Aids to Effective Production Management." Organised in conjunction with Work Study Society by Society of Industrial Engineers, 28 Victoria-street, London, S.W.1.

Arizona State Fair.—Fri., Nov. 4, to Sun., Nov. 13, at Phoenix, Arizona, U.S.A. There is a United Kingdom Exhibit. Apply to the British Consulate General, 448 South Hill-street, Los Angeles 13, Calif., U.S.A.

Bottling and Allied Industries Exhibition and Packing and Distributing Exhibition.—Sat., Nov. 5, to Mon., Nov. 14, in Paris. *Agents:* General-Tours Agence Generale de Tourisme (U.K.), Ltd., 25 and 26 Park-lane, London, W.1. Tel. HYDe Park 6854.

***Exhibition of Equipment for the Food Industries, International.**—Sat., Nov. 5, to Mon., Nov. 14, in Paris. Apply to General-Tours Agence General de Tourisme (U.K.), Ltd., 25 and 26 Park-lane, London, W.1. Tel. HYDe Park 6854.

Dairy Equipment Exhibition, International.—Sat., Nov. 5, to Mon., Nov. 14, in Paris. *Agents:* Général-Tours Agence Générale de Tourisme (U.K.), Ltd., 25 and 26 Park-lane, London, W.1. Tel. HYDe Park 6854.

Mechanical Handling Exhibition.—Sat., Nov. 5, to Mon., Nov. 14, in Paris. Apply to the director, Salon de la Manutention, 40 Rue du Colisée, Paris 8e.

Eastern Joint Computer Conference.—Mon., Nov. 7, to Wed., Nov. 9, at the Hotel Statler, Boston, Mass., U.S.A. Apply to the organisers at that address.

National Packaging Exposition, Fourth.—Tues., Nov. 8, to Thurs., Nov. 10, at Toronto. Organised by the Packaging Association of Canada, 916 Yonge-street, Toronto, Canada.

Canada's Power Show.—Tues., Nov. 8, to Fri., Nov. 11, at the Show Mart Building, Montreal. Sponsored by the Institute of Power Engineers, 1176 Sherbrooke-street West, Montreal.

Metal-Phase Transformations Symposium.—Wed., Nov. 9, in London. Apply to the Institute of Metals, 4 Grosvenor-gardens, London, S.W.1. Tel. SLOane 6233. See ENGINEERING, December 3, 1954, page 723.

***Society of Naval Architects and Marine Engineers, 63rd Annual Meeting.**—Wed., Nov. 9, to Sat., Nov. 12, at the Waldorf-Astoria Hotel, Park-avenue, New York 22, U.S.A. Offices of the Society: 74 Trinity-place, New York 6.

Hotel and Allied Industries Equipment Exhibition.—Thurs., Nov. 10, to Mon., Nov. 21, in Paris. *Agent:* Mr. R. C. Liebman, 178 Fleet-street, London, E.C.4. Tel. CITy 5889.

Royal Agricultural Winter Fair.—Fri., Nov. 11, to Sat., Nov. 19, at Toronto. Organised by the Royal Winter Fair Authorities, Royal Coliseum, Exhibition Park, Toronto 2B, Canada.

Scottish Motor Exhibition.—Fri., Nov. 11, to Sat., Nov. 19, at Glasgow. Organised by Scottish Motor Trade Association Ltd., 3 Palmerston-place, Edinburgh, 12. Tel. Central 3643.

Model Engineers' Exhibition, Ninth International.—Sat., Nov. 12, to Thurs., Dec. 15, at Bombay. Apply to Mr. M. P. Polson, Noble Chambers, Parsi Bazar-street, Fort, Bombay.

***Cycle and Motor Cycle Show, 30th International.**—Sat., Nov. 12, to Sat., Nov. 19, at Earl's Court, London, S.W.5. Organised by the British Cycle and Motor Cycle Manufacturers' and Traders' Union, Ltd., 20-23 Lincoln's Inn Fields, London, W.C.2. Tel. CHAncery 4152.

Automation Exposition, Second International.—Mon., Nov. 14, to Thurs., Nov. 17, at the Navy Pier, Chicago. Organised by Richard Rimbach Associates, 845 Ridge-avenue, Pittsburg 12, Pa., U.S.A.

Chicago Exposition of Power and Mechanical Engineering.—Mon., Nov. 14, to Fri., Nov. 18, at the Coliseum, Chicago, Ill., U.S.A., under the auspices of the American Society of Mechanical Engineers. Apply to the International Exposition Co., 480 Lexington-avenue, New York 17, U.S.A.

Building Exhibition, 26th.—Wed., Nov. 16, to Wed., Nov. 30, at Olympia, London, W.14. Apply to the Building Trades Exhibition, 4 Vernon-place, London, W.C.1. Tel. CHAncery 2223.

Protection of Cable Sheathing Against Corrosion, Symposium.—Fri., Nov. 18, at the Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. Organised by the Corrosion Group, Society of Chemical Industry, 56 Victoria-street, London, S.W.1. Tel. VICtoria 5215. Apply to Mr. S. C. Britton, Group hon. secretary, Tin Research Institute, Fraser-road, Greenford, Middlesex.

Seattle Boat Show.—Sat., Nov. 19, to Sun., Nov. 27, in Seattle Field Artillery Armoury. Apply to the general manager, 800 8th-avenue, Seattle 4, Wash., U.S.A.

***Radio and Communications Exhibition, International.**—Sat., Nov. 19, to Wed., Nov. 30, at Ljubljana. Apply to Gospodarsko Rastavisce, Titova 50, Ljubljana, Yugoslavia.

Documentation of Applied Chemistry Congress.—Tues., Nov. 22, to Fri., Nov. 25, at the Institut Français du Royaume Uni, Queensberry-place, London, S.W.7. Apply to the International Congress on Documentation of Applied Chemistry, 56 Victoria-street, London, S.W.1. Tel. VICtoria 5974.

***Flame-Resistant Polymers.**—Wed. and Thurs., Nov. 23 and 24, at the National College of Rubber Technology, Holloway-road, London, N.7. Symposium organised by *The Rubber and Plastics Age*, 147 Grosvenor-road, London, S.W.1. Tel. VICtoria 1150.

Colombian Second International Industrial Fair.—Fri., Nov. 25, to Sun., Dec. 11, at Bogota, Colombia. Apply to the Colombian Embassy, 3 Hans-crescent, London, S.W.1. Tel. KENsington 9177.

Symposium on Corrosion.—Mon., Nov. 28, to Fri., Dec. 2, at The University, Melbourne. Organised by the University of Melbourne, the Institution of Engineers, Royal Australian Chemical Institute, Australian Institute of Metals, Society of Chemical Industry, Australasian Institute of Mining and Metallurgy, and Australian Association for Corrosion Prevention. Apply to the honorary secretary, Symposium on Corrosion, Metallurgy Department, University of Melbourne, Carlton N.3, Victoria, Australia.

British Nuclear Energy Conference, London Meeting.—Wed., Nov. 30, at the Institution of Civil Engineers, Great George-street, London, S.W.1. Symposium of lectures. Attendance is restricted to members of the five institutions participating in the Conference. Information obtainable from the secretary of the Conference, Mr. A. McDonald, 1-7 Great George-street, London, S.W.1. See ENGINEERING, September 9, page 329.

Hong Kong Products Exhibition (13th), Including International Machinery Display.—Fri., Dec. 2, 1955, to Mon., Jan. 2, 1956, in Hong Kong. Apply to the Chinese Manufacturers' Union, 64-65 Connaught-road Central, Hong Kong.

Smithfield Show and Agricultural Machinery Exhibition.—Mon., Dec. 5, to Fri., Dec. 9, at Earl's Court, London, S.W.5. Apply to the exhibition manager, Smithfield Show Joint Committee, 148 Piccadilly, London, W.1. Tel. GROsvenor 4040.

Chemical Industries Exposition.—Mon., Dec. 5, to Fri., Dec. 9, at the Commercial Museum and Convention Hall, Philadelphia, Pa., U.S.A. Organised by the International Exposition Co., 480 Lexington-avenue, New York 17.

Aluminium in Shipbuilding.—Wed. and Thurs., Dec. 7 and 8, at 10 Upper Belgrave-street, London, S.W.1. Joint symposium on "Use and Welding of Aluminium in Shipbuilding," organised by the Institute of Welding, the Institution of Naval Architects, the British Shipbuilding Research Association, the British Welding Research Association and the Aluminium Development Association. Apply to the secretary, Institute of Welding, 2 Buckingham Palace-gardens, London, S.W.1. Tel. SLOane 9851.

National Boat Show, Second.—Thurs., Dec. 29, 1955 to Tues., Jan. 10, 1956, at Olympia, London, W.14. Organised by the Ship and Boat Builders' National Federation, 205 Regent-street, London, W.1. Tel. REGent 1108.

***Indian Science Congress Association, 43rd Meeting.**—Mon., Jan. 2, to Sun., Jan. 8, 1956, at Agra. Offices of the Association: 1 Park-street, Calcutta 16, India.

Kitale Air Show.—Fri., Jan. 6, to Sun., Jan 8, 1956, at Kitale, Kenya. Further information obtainable from Captain N.E. Waugh, Harward, Maclachlan & Co., Ltd., P.O. Box 2159, Nairobi, Kenya.

Royal Agricultural and Food Exhibition.—Thurs., Jan. 12, to Thurs., Jan. 26, 1956, at the Ceylon Turf Club, Colombo. Agricultural and dairy machinery exhibits. Organised by the Exhibition Branch, Department of Commerce, P.O. Box 1507, Colombo, Ceylon.

***Pakistan Science Congress, Eighth Annual.**—Mon., Jan. 16, to Sat., Jan. 21, 1956, at Dacca, East Pakistan. Organised by the Pakistan Association for the Advancement of Science. Apply to Dr. Bashir Ahmad, University Institute of Chemistry, The Mall, Lahore, Pakistan.

***New York Lamp Show.**—Sun., Jan. 22, to Fri., Jan. 27, 1956, at New Yorker Hotel, New York. Apply to Mr. George F. Little, 220 Fifth-avenue, New York 1. See also Lamp Show on July 8 to 13.

***American Institute of Electrical Engineers, Winter General Meeting.**—Mon., Jan. 30, to Fri., Feb. 3, 1956, at New York. Offices of the Institute: 33 West 39th-street, New York 18, U.S.A.

***Canadian Hardware and Housewares Exhibition.**—Mon., Feb. 6, to Thurs., Feb. 9, 1956, in the Automotive Building, Canadian National Exhibition Grounds and the Royal York Hotel, Toronto. Information obtainable from Mr. A. P. Wales, Dudley House, Southampton-street, London, W.C.2. Tel. TEMple Bar 8947.

***Winter Concreting Symposium.**—Sun., Feb. 12, to Fri., Feb. 17, 1956, at Copenhagen. Apply to the organising secretary, Rilem Symposium 1956, c/o The Danish National Institute of Building Research, 20 Borgergade, Copenhagen K, Denmark.

***Scottish Dairy Show.**—Tues., Feb. 14, to Fri., Feb. 17, 1956, at Kelvin Hall, Glasgow. Organised jointly by the Corporation of Glasgow, and the Glasgow Agricultural Society, Kelvin Hall, Glasgow.

***American Institute of Mining and Metallurgical Engineers, Annual Meeting.**—Sun., Feb. 19, to Thurs., Feb. 23, 1956, at New York. Offices of the Institute: 29 West 39th-street, New York 18, U.S.A.

***Radio and Domestic Appliance Exhibition.**—Wed., Feb. 22, to Sat., Feb 25, 1956, in the Memorial Hall, Nairobi. Organised by the Radio Traders' Association of East Africa, P.O. Box No. 6742, Nairobi, Kenya.

***Modern Gardening Equipment Exhibition.**—Thurs., Feb. 23, to Thurs., Mar. 1, 1956, at the Central Hall, Westminster, London, S.W.1. Organised by Universal Exhibitions Ltd., 74 Holland Park, London, W.11. Tel. PARk 7360.

***American Society for Testing Materials.**—*National Meeting:* Mon., Feb. 27, to Fri., Mar. 2, 1956, at the Hotel Statler, Buffalo, N.Y. *Annual Meeting:* Sun., June 17, to Fri., June 22, 1956, at Atlantic City, N.J. Held in association with the Exhibit of Testing and Scientific Apparatus. *Pacific Coast National Meeting:* Sun., Sept. 16, to Sat., Sept. 22, 1956, at the Hotel Statler, Los Angeles, Calif. Offices of the Society 1916 Race-street, Philadelphia, Pa., U.S.A.

***Frankfurt International Spring Fair.**—Sun., Mar. 4, to Thurs., Mar. 8, 1956, at Frankfurt. *Agents:* Lep Transport Ltd., Sunlight Wharf, Upper Thames-street, London, E.C.4. Tel.: CENtral 5050.

***National Association of Corrosion Engineers.**—Mon., Mar. 12, to Fri., Mar. 16, 1956, at New York. Conference. Offices Southern Standard Building, Houston 2, Texas, U.S.A.

***Plant and Process Dynamic Characteristics, Conference on.**—Wed., April 4, to Fri., April 6, 1956, at the Engineering Laboratory, The University, Cambridge. Organised by the Control Section of the Society of Instrument Technology, 184 Sherwood Park-road, Mitcham, Surrey. (Tel. POLlards 3620). Apply to the secretary, S.I.T. 1956 Conference, Engineering Laboratory, Trumpington-street, Cambridge.

***Education of the Young Worker.**—Sat., April 7, to Fri., April 13, 1956, at Oriel College, Oxford. Conference organised by the Education Department of the University of Oxford. Apply to the secretary, Young Worker Conference, 15 Norham-gardens, Oxford. Tel. Oxford 58631.

***Electrical Association for Women, 31st Annual Conference.**—Mon., April 30, to Thurs., May 3, 1956, at Llandudno. Main theme will be "Planning for Light." Apply to the offices of the Association, 25 Foubert's-place, London, W.1. Tel. GERrard 5212.

***Domestic Heating in the United Kingdom: Present and Future.**—Tues. and Wed., May 1 and 2, 1956, at Church House, Westminster, London, S.W.1. Opening conference of a special study on this subject. Organised by the Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1. Tel. LANgham 7124.

***Valencia Samples Fair, 34th International.**—Tues., May 1, to Sun., May 20, 1956, at Valencia. Organised by the Feria Muestrario International de Valencia, Llano del Real 2, Valencia. Information obtainable from the Economic Department, Spanish Embassy, 12 Cadogan-place, London, S.W.1. Tel. SLOane 6181.

***Strength of Concrete Structures Symposium.**—Wed., May 16, to Fri., May 18, 1956, at the Institution of Civil Engineers, Great George-street, London, S.W.1. Organised, in association with the Joint Committee on Structural Concrete, by the Cement and Concrete Association, 52 Grosvenor-gardens, London, S.W.1. Tel. SLOane 5255. See also page 603.

***British Electrical Power Convention.**—Wed., May 23, to Tues., May 29, 1956, at Torquay. Theme: "Electricity and Transport." Offices of the Convention: Winsley-street, London, W.1. Tel. MUSeum 4040.

***Vapour-Phase Chromatography.**—Wed., May 30, to Fri., June 1, 1956, in London. Organised by the Hydrocarbon Research Group of the Institute of Petroleum, 26 Portland-place, London, W.1. (Tel. LANgham 2250). Apply to the organising secretaries: Mr. D. M. Desty and Mr. H. C. Rampton, The Research Station, British Petroleum Co., Ltd., Sunbury-on-Thames.

***Bath and West Agricultural Show.**—Wed., May 30, to Sat., June 2, 1956, at Cardiff. Organised by the Bath and West and Southern Counties Society, 3 Pierrepont-street, Bath. Tel. Bath 3010.

***Barcelona Samples Fair, 24th International**—Fri., June 1, to Wed., June 20, 1956, at Barcelona. Apply to the Spanish Tourist Service, 4 West Halkin-street, Belgrave-square, London, S.W.1. Tel. SLOane 6124; or to the Economic Department, Spanish Embassy, 12 Cadogan-place, London, S.W.1. Tel. SLOane 6181.

***Testing and Scientific Apparatus and Laboratory Supplies, 12th Exhibit of.**—Sun., June 17, to Fri., June 22, 1956, at Atlantic City, N.J. Organised by the American Society for Testing Materials in connection with their Annual Meeting. Offices of the Society: 1916 Race-street, Philadelphia 3, Pa., U.S.A.

***New York Lamp Show.**—Sun., July 8, to Fri., July 13, 1956, at New Yorker Hotel, New York. Apply to Mr. George F. Little, 220 Fifth-avenue, New York, 1. See also Lamp Show on Jan. 22 to 27.

***Duke of Edinburgh's Study Conference on Human Problems of Industrial Communities within the Commonwealth and Empire.**—Mon., July 9, to Fri., July 27, 1956, at Oxford.

***Great Yorkshire Agricultural Show.**—Tues., July 10, to Thurs., July 12, 1956, at Harrogate. Organised by the Yorkshire Agricultural Society, Cliftonfield, Shipton-road, York. Tel. York 3102.

***Royal Welsh Agricultural Show.**—Wed., July 25, to Fri., July 27, 1956, at Rhyl. Apply to the secretary, the Royal Welsh Agricultural Society, Queen's-road, Aberystwyth. Tel. Aberystwyth 7551.

***British Association Meeting.**—Wed., Aug. 29, to Wed., Sept. 5, 1956, in Sheffield. Apply to the secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1. Tel. REGent 2109.

***Foundry Trades Fair, International (GIFA).**—Sat., Sept. 1, to Sun., Sept. 9, 1956, at the Fair Halls, Düsseldorf. To be held in connection with the 23rd International Foundry Congress. Organised by the Nordwestdeutsche Ausstellungs-Gesellschaft m.b.H. (NOWEA), Ehrenhof 4, Düsseldorf, Germany. *Agents:* John E. Buck & Co., 47 Brewer-street, London, W.1. Tel. GERrard 7576. See ENGINEERING, October 21, 1955, page 565.

***Strasbourg European Fair, 31st.**—Sat., Sept. 1, to Sun., Sept. 16, 1956, at Strasbourg. *Agent:* R. C. Liebman, 178 Fleet-street, London, E.C.4. Tel. CITy 5889.

***Frankfurt International Autumn Fair.**—Sun., Sept. 2, to Thurs., Sept. 6, 1956, at Frankfurt. *Agents:* Lep Transport, Ltd., Sunlight Wharf, Upper Thames-street, London, E.C.4. Tel. CENtral 5050.

***German Agricultural Show.**—Sun., Sept. 9, to Sun., Sept. 16, 1956, at Hanover. Apply to the Deutsche Landwirtschafts-Gesellschaft, Niedenau 48, Frankfurt-on-Main.

***High Speed Photography, Third International Congress and Exhibition.**—Mon., Sept. 10, to Sat., Sept. 15, 1956, at Government Offices, Horse Guards-avenue, London, S.W.1. Sponsored by the Department of Scientific and Industrial Research. Apply to the Congress Secretariat, D.S.I.R., Charles House, 5–11 Regent-street, London, S.W.1. Tel. WHItehall 9788.

***Building Plant Exhibition.**—Wed., Sept. 12, to Wed., Sept. 19, 1956, at the D and E Car Parks, Gosforth Park Racecourse, Great North-road, Newcastle-upon-Tyne. Organised by the Ministry of Works, Lambeth Bridge House, London, S.E.1. Tel. RELiance 7611.

***Function and Education of Welding Engineers, Conference on.**—In mid-September, 1956. Organised by the Institute of Welding, 2 Buckingham Palace-gardens, London, S.W.1. Tel. SLOane 9851.

***National Fuel Efficiency Exhibition.**—Tues., Oct. 2, to Wed., Oct. 10, 1956, at Olympia, London, W.14. Organised by Provincial Exhibitions Ltd., City Hall, Deansgate, Manchester, 3. Tel. Deansgate 6363.

NOTICES OF MEETINGS

Association of Engineering Distributors

LONDON
Annual General Meeting. Park Lane Hotel, Piccadilly, W.1. Tues., Nov. 1, 11 a.m. Followed by Annual Luncheon.

Association of Supervising Electrical Engineers

LONDON
"Engineering in the West Indies," by H. Clifton. West London Branch. Windsor Castle Hotel, 134 King-street, Hammersmith, W.6. Tues., Nov. 1, 7.30 p.m.
Discussion on "Transformers." South East London Branch. Congregational Church Hall, Court-road, Eltham. Tues., Nov. 1, 8 p.m.
"Suppression of Interference," by A. Hale. North London Branch. Queen's Head, 677 Green Lanes, N.4. Wed., Nov. 2, 7.45 p.m.
CARDIFF
Film Evening. South Wales Branch. Angel Hotel, Westgate-street, Cardiff. Tues., Nov. 1, 7.30 p.m.
LIVERPOOL
"Electro-Static Precipitation," by J. A. Quarrington. Liverpool Branch. 9 The Temple, 24 Dale-street, Liverpool. Fri., Nov. 4, 7.30 p.m.
MANCHESTER
Discussion on "Radio Astronomy." Manchester Branch. Engineers' Club, Albert-square, Manchester. Wed., Nov. 2, 7.30 p.m.

British Institution of Radio Engineers

MANCHESTER
"Ground-Controlled Approach and the Instrument-Landing System," by R. H. James and N. MacKinnon. Preceded by film: "In on the Beam." North Western Section. College of Technology, Manchester. Thurs., Nov. 3, 6.30 p.m.

Building Centre

LONDON
Films: "Joints in Civil Engineering and Building," and "Joints that Move." Wed., Nov. 2, 12.45 p.m.

Chemical Society

LONDON
Various original papers. Thurs., Nov. 3, 7.30 p.m.
BRISTOL
"New Aspects of the Chemistry of the Nitrogen Oxides," by Dr. C. C. Addison. Bristol Branch. Chemistry Department, The University, Bristol. Thurs., Nov. 3, 7 p.m.
DURHAM
"Recent Researches on the Metal Alkoxides," by Professor W. Wardlaw. Newcastle and Durham Branch. Science Laboratories, South-road, Durham. Mon., Oct. 31, 5.15 p.m.
MANCHESTER
Centenary Lecture on "The Photosynthetic Carbon Cycle," by Professor M. Calvin. Manchester Branch. The University, Manchester. Tues., Nov. 1, 6.30 p.m.
NEWCASTLE-UPON-TYNE
Various original papers. Newcastle and Durham Branch. Chemistry Building, King's College, Newcastle-upon-Tyne. Fri., Nov. 4, 4 p.m.

Illuminating Engineering Society

CARDIFF
"Problems of Production Lighting in Television Studios," by R. de B. McCullough. Cardiff Centre. Offices of the South Wales Electricity Board, The Hayes, Cardiff. Thurs., Nov. 3, 5.45 p.m.
GLASGOW
"Maintenance of Lighting Installations," by J. W. Strange and W. Robinson. Glasgow Centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Thurs., Nov. 3, 6.30 p.m.
NOTTINGHAM
"Lighting of Hazardous and Corrosive Locations in Industrial Plants," by W. E. Harper and A. G. Palmer. Nottingham Centre. Offices of the East Midlands Electricity Board, Smithy-row, Nottingham. Thurs., Nov. 3, 6 p.m.

Incorporated Plant Engineers

LONDON
"Corrosion and Fouling in Industry," by E. J. Bradbury. London Branch. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Tues., Nov. 1, 7 p.m.
EDINBURGH
"Factory Heat Analysis," by G. E. H. Lewis. Edinburgh Branch. 25 Charlotte-square, Edinburgh. Tues., Nov. 1, 7 p.m.
LEICESTER
"Combustion Systems for Aero-Gas Turbines," by S. L. Bragg. Leicester Branch. College of Art and Technology, The Newarkes, Leicester. Wed., Nov. 2, 6.30 p.m.
PETERBOROUGH
"Engineering Economics," by T. S. Welch. Peterborough Branch. Campbell Hotel, Bridge-street, Peterborough. Thurs., Nov. 3, 7.30 p.m.
SOUTHAMPTON
"Industrial Fires and Their Prevention," by E. T. Hayward, Southern Branch. Polygon Hotel, Southampton. Wed., Nov. 2, 7.30 p.m.

Institute of Fuel

SWANSEA
"Electrical Hazards in Inflammable Atmospheres," by G. D. Curtis. South Wales Section. Central Library Alexandra-road, Swansea. Fri., Nov. 4, 6 p.m.

Institute of Industrial Supervisors

LONDON
"Managerial Authority," by D. H. Bramley. London Central Section. The Polytechnic, Regent-street, W.1. Thurs., Nov. 3, 7.30 p.m.

Institute of Refrigeration

LONDON
Presidential Address by Lord Dudley Gordon. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Thurs., Nov. 3, 5.30 p.m.

Institute of Road Transport Engineers

BRISTOL
"A Talk on Girling Products and the Servicing of the Same," by T. J. Phipps. Western Centre. Royal Hotel, Bristol. Wed., Nov. 2, 7.30 p.m.
PETERBOROUGH
"Two-Way Radio as an Aid to the Control of Large Fleets of Goods and Passenger Vehicles," by E. N. Farrer. Eastern Centre. Offices of F. Perkins Ltd., Peterborough. Tues., Nov. 1, 6.30 p.m.

Institution of Civil Engineers

LONDON
Presidential Address by W. K. Wallace. Tues., Nov. 1, 5.30 p.m.
MANCHESTER
"The Volga-Don Canal," by J. B. Scott. North Western Association. Engineers' Club, Albert-square, Manchester. Thurs., Nov. 3, 6.30 p.m.
NOTTINGHAM
Film Evening, and Chairman's Address, by R. H. Lee. Nottingham Mechanics' Institute, Trinity-square, Nottingham. Tues., Nov. 1, 6.15 p.m.

Institution of Electrical Engineers

LONDON
"The Technique of Ionospheric Investigation, Using Ground Back-Scatter," by E. D. R. Shearman; "A Study of Ionospheric Propagation by Means of Ground Back-Scatter," by E. D. R. Shearman; "An Experiment to Test the Reciprocal Radio Transmission Conditions Over an Ionospheric Path of 740 km." by R. W. Meadows; and "An Experimental Test of Reciprocal Transmission Over Two Long-Distance High-Frequency Radio Circuits," by F. J. M. Laver and H. Stanesby, at 2.30 p.m., and—
"Very-High Frequency Propagation by Ionospheric Scattering and Its Application to Long-Distance Communication," by W. J. Bray and others, at 5.30 p.m. Radio and Telecommunication Section. Mon., Oct. 31.
Discussion on "Fault Recording Instrumentation on a Power-Supply System," opened by W. Casson and Laszlo Csuros. Measurement and Control Section. Tues., Nov. 1, 5.30 p.m.
"The New High-Frequency Transmitting Station at Rugby," by Captain C. F. Booth and B. N. MacLarty. Thurs., Nov. 3, 5.30 p.m.
"Communication of Information: Human, Animal and Machine," by Dr. E. Colin Cherry. London Graduates' and Students' Section. Wed., Nov. 2, 6.30 p.m.
HOVE
"Automatic Circuit Reclosers," by G. F. Peirson, A. H. Pollard and N. Care. Southern Centre. Offices of the South Eastern Electricity Board, Hove. Wed., Nov. 2, 6.30 p.m.
LEEDS
"A Transatlantic Telephone Cable," by Dr. M. J. Kelly, Sir Gordon Radley, G. W. Gilman and R. J. Halsey. North Midland Centre. Offices of the Yorkshire Electricity Board, 1, Whitehall-road, Leeds. Tues., Nov. 1, 6.30 p.m.
MANCHESTER
"The Adhesion of Electric Locomotives," by Dr. H. I. Andrews. North Western Centre. Engineers' Club, Albert-square, Manchester. Tues., Nov. 1, 6.15 p.m.

Institution of Engineering Designers

NEWCASTLE-UPON-TYNE
"Design for Welding," by H. Roscoe. North East Branch. Northern Architectural Association's Hall, 6 Higham-place, Newcastle-upon-Tyne. Mon., Oct. 31, 7.15 p.m.

Institution of Engineering Inspection

BIRMINGHAM
"Measurement of Production," by S. F. Ellerby. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham, 2. Wed., Nov. 2, 7.30 p.m.
COVENTRY
"Quality Castings in Light Alloys," by P. A. Broadbent. Coventry Branch. Technical College, Coventry. Tues., Nov. 1, 7.30 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Aluminium Tanker," by Dr. E. C. B. Corlett. Tues., Nov. 1, 7.30 p.m.

Institution of Heating and Ventilating Engineers

BIRMINGHAM
Film Evening. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham. Thurs., Nov. 3, 6.30 p.m.
NOTTINGHAM
"Medium-Pressure Hot-Water Systems," by T. H. F. Holman. East Midlands Branch. College of Arts and Crafts, Waverley-street, Nottingham. Wed., Nov. 2, 6.45 p.m.

Institution of Mechanical Engineers

LONDON
"Experiments on a Small Pump Suction Well, with Particular Reference to Vortex Formations," by Dr. E. Markland and Professor J. A. Pope; and "An Experimental Study of Air-Entraining Vortices in Pump Sumps," by Dr. D. F. Denny. Fri., Nov. 4, 5.30 p.m.
"A Criticism of the Technical Education of Recently Qualified Engineers," by P. P. Love. Education Group. Fri., Nov. 11, 5.30 p.m.
COVENTRY
Chairman's Address by Dr. C. G. Williams. Coventry A. D. Centre. Leofric Hotel, Coventry. Tues., Nov. 1, 7.15 p.m.
NOTTINGHAM
"Co-operation in Engineering Research Between Educational Institutions and Industry," by Professor E. Giffen, V. C. Davies and J. H. R. Nixon. East Midlands Branch. Engineering Department, The University, Nottingham. Wed., Nov. 2, 7.30 p.m.
MANCHESTER
"Rapid-Starting Technique: Some Significant Tests at Poole Power Station," by J. S. Hall and A. D. Brittin. North Western Branch. Engineers' Club, Albert-square, Manchester. Thurs., Nov. 3, 6.45 p.m.
SLOUGH
Chairman's Address on "Aero-Engines—Past, Present and Future," by Professor A.D. Baxter. Eastern Branch. Good Companions Hotel, Slough. Thurs., Nov. 3, 7.30 p.m.

Institution of Production Engineers

BASINGSTOKE
"Glass Fibre and Its Use in Reinforced Plastics," by A. R. Hennings. Reading Section. Canteen of Transport Equipment (Thornycroft), Ltd., Basingstoke. Thurs., Nov. 3, 7.30 p.m.
GLASGOW
Discussion Meeting. Glasgow Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Thurs., Nov. 3, 7.30 p.m.
ILFORD
"Powder Metallurgy," by G. R. Bell. South Essex Section. Ilford Club, 21a Balfour-road, Ilford. Wed., Nov. 2, 7.30 p.m.
MIDDLESBROUGH
"The Practical Application of Production-Engineering Research," by Dr. D. F. Galloway. Tees-Side Section. Cleveland Scientific and Technical Institute, Corporation-road, Middlesbrough. Tues., Nov. 1, 7 p.m.
PETERBOROUGH
"The Shell Moulding Process," by D. N. Buttrey. Peterborough Section. Campbell Hotel, Bridge-street, Peterborough. Wed., Nov. 2, 7.30 p.m.
STAFFORD
"Increased Automation of Existing Production Lines," by J. B. Jay. Wolverhampton Section. Stafford Technical College, Stafford. Wed., Nov. 2, 7.15 p.m.

Institution of Structural Engineers

BIRMINGHAM
"Design of a Building," by E. Shepley. Midland Counties Branch. Birmingham and Midland Institute, Paradise-street, Birmingham. Tues., Nov. 1, 6 p.m.
CARDIFF
"Recent Trends in the Design of Industrial Buildings," by A. V. Hooker. Wales and Monmouthshire Branch. South Wales Institute of Engineers, Park-place, Cardiff. Tues., Nov. 1, 6.30 p.m.
DERBY
"Derby Station: Reconstruction of Platform Roofs," by W. C. Clenshaw. Midland Counties Branch. Becket Sale Rooms, Derby. Thurs., Nov. 3, 7 p.m.
MIDDLESBROUGH
"Castellated Construction," by H. Saunders. Northern Counties Branch. Cleveland Scientific and Technical Institute, Corporation-road, Middlesbrough. Tues., Nov. 1, 6.30 p.m.
NEWCASTLE-UPON-TYNE
"Castellated Construction," by H. Saunders. Northern Counties Branch. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Wed., Nov. 2, 6.30 p.m.

Institution of Works Managers

SHEFFIELD
"Accent on Management," by E. V. Ward. Sheffield Branch. Grand Hotel, Sheffield. Tues., Nov. 1, 7.30 p.m.

Junior Institution of Engineers

LONDON
Film on "Diesel-Electric Locomotives," to be introduced by R. M. Tufnell. Fri., Nov. 4, 7 p.m.
BIRMINGHAM
"Design, Control and Operation of Metallurgical Furnaces for the Non-Ferrous Metals Industry," by R. M. Jones. Midland Section. James Watt Memorial Institute, Great Charles-street, Birmingham. Wed., Nov. 2, 7 p.m.

Manchester Association of Engineers

MANCHESTER
"The Management of Men," by the Bishop of Manchester. Engineers' Club, Albert-square, Manchester. Fri., Nov. 4, 6.45 p.m.

Reinforced Concrete Association

LIVERPOOL
"New Northam Bridge, Southampton," by J. Cuerel. North Western Branch. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Wed., Nov. 2, 6.30 p.m.
MANCHESTER
"New Northam Bridge, Southampton," by J. Cuerel. North Western Branch. College of Technology, Sackville-street, Manchester. Tues., Nov. 1, 6.45 p.m.

Royal Institution

LONDON
"Large-Scale Weather Processes—I," by Dr. R. C. Sutcliffe. Thurs., Nov. 3, 6 p.m.
"Weather Forecasting," by Sir Graham Sutton. Fri., Nov. 4 9 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"Strain-Ageing in Deep Drawing Mild Steels," by Dr. B. B. Hundy. B.I.S.R.A. Laboratories, Hoyle-street, Sheffield, 3. Tues., Nov. 1, 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

Association of Engineering Distributors, Hastings House, Norfolk-street, London, W.C.2. (TEMple Bar 4941.)
Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1. (MUSeum 1901.)
Building Centre, 26 Store-street, London, W.C.1 (MUSeum 5400.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1. (LANgham 7124.)
Institute of Industrial Supervisors, 24 Albert-street, Birmingham, 4. (Midland 6971.)
Institute of Refrigeration, Dalmeny House, Monument-street, London, E.C.3. (MINcing Lane 6851.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland-place, London, W.1. (LANgham 8847.)
Institution of Engineering Inspection, 28 Victoria-street, London, S.W.1. (ABBey 3794.)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. (Central 5181.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1. (SLOane 7128.)
Institution of Works Managers, 67-68 Chandos-place, London, W.C.2. (TEMple Bar 8324.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
Manchester Association of Engineers, 18 Booth-street, Manchester 2. (Central 1717.)
Reinforced Concrete Association, 94-98 Petty France, London, S.W.1. (ABBey 4504.)
Royal Institution, 21 Albemarle-street, London, W.1. (HYDe Park 0669.)
Sheffield Metallurgical Association, 15 Crescent-road, Sheffield 7, (Sheffield 53674.)

THE HUMAN ELEMENT

National compaign to reduce accidents. "More-than-full" employment is causing job discrimation and maldistribution. Labour relations in the gas industry—a new pension scheme proposed. Expansion in management training may be limited by overhead costs. Analysing labour stability as distinct from turnover. The two extremes that hamper production.

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Safety in Industry

A major campaign was opened last Monday by the Royal Society for the Prevention of Accidents, to promote safer working in industry. In its announcement, the Industrial Safety Division of the Society pointed out that six million minor and major accidents occur in industry each year, of which 800 are fatal. They suggest that with care the majority could be avoided, and the main purpose of the National Safety Week which began on October 24 is to drive this home to as many workers as possible. Managements are co-operating with the Society and nearly one million copies of a leaflet specially produced for the occasion by the Ro.S.P.A., "How to Last a Lifetime," are being distributed in factories, building sites and on the railways all over the country. A film, "The Man who Stops Accidents," has been screened on the B.B.C. television, and the Lord Mayor of London is opening a conference at the Guildhall which will be addressed by the Minister of Labour and three leading industrialists.

The leaflet, which is well and simply written, contains 12 small but striking cartoons each illustrating a typical accident due to neglect or carelessness. The recommendations are for elementary precautions to avoid what are presumably the 12 chief causes of industrial accidents. ENGINEERING wishes the organisers of the campaign every success in their efforts to reduce accidents in working time.

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A Question of 0·9 Per Cent.

Since the middle of this summer the percentage of unemployment in industry has been 0·9. For some time the figure had hovered round the tidy level of 1 per cent. which has been accepted for a while as the sign of more than full employment. To get inside this figure must be the signal for someone to think of a new term which means rather more than over-full employment. Meanwhile, signs are not lacking that this very low percentage is causing serious maldistribution of the labour force. This is particularly true in the London and Birmingham areas where there are thousands of vacancies and no men to fill them; on the other hand there are areas such as Scotland where there is a certain amount of slack still to be taken up in a few localities. If labour were willing to move more freely from one place to another this acute labour shortage could be alleviated to some extent, but the housing shortage is acting as a serious brake on this.

Signs of distortion in the labour market are becoming more frequent. Jobs which are likely to have round-the-clock working hours and unpleasant occupations are at a heavy discount in highly industrialised areas—less so in rural parts. Many bus services (London is a critical case) are undermanned and West Indian labour is moving in to fill the gap. The railways are also suffering. In the Birmingham area there are 1,000 vacancies unfilled and goods services have had to be cut. On the other hand, there is something of a surplus of railway labour if it could be tapped in rural areas. Among unpleasant occupations, coal heaving has provided a notable example in the last week when a well-known company of coal merchants in Oxford has decided to discontinue its retail coal distribution business (it has 7,000 registered customers) because labour cannot be found to load coal. There is evidence here and there that companies are beginning to bid against one another for labour. These are all signs that men can get good wages somewhere else, and no one would grudge them that. But under present conditions, it means that wages are running well ahead of production, and that can only bring inflation which benefits no one in the long run.

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Welfare and Wages in Gas

Concentration of production on efficient works, and a consequent gradual reduction in the numbers employed in the industry, has in no way prevented the gas industry from developing a policy of enlightened labour relations, a policy which was a feature of most sections of the industry back in the days of private enterprise. During the financial year ended March, 1955, wage increases amounting to almost £2·6 million were agreed with the unions. The outline of a pension scheme for manual workers has been submitted to the Ministry and if this is adopted it will be one more nationalised industry to provide a working example of how these kinds of arrangement can be extended beyond the limits of clerical staff.

Over 9,000 employees in the industry were following some sort of course in training or education with the assistance of the area boards. Further residential courses in management and general subjects have been held by the Gas Council. Since there were over 143,000 employed in the industry at March, 1955, this figure represents about 2 per cent. of the labour force.

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Competition in Management Colleges?

How many management colleges and management courses does industry need at present? The answer to this question is by no means as easy to give as might at first sight appear. Many people, including those who consider that systematic training of management in British industry is carried out on a woefully small scale, would say that the scope for expansion in this field is enormous, and that the number of recruits for management training far exceeds the facilities available. This may well be true up to a point but it is not yet the attitude of British industry as a whole. The potential demand, or the need for management training is probably very big indeed, but the actual demand is much more limited. There is definitely a limit to the amount of money which companies are prepared to spend on training their bright young men.

Most of the universities have now established some kind of industrial management course. There are courses, residential and otherwise, for technicians and various kinds of supervisors and foremen. There are a number of residential staff colleges. Last week a new residential college for executives at Sundridge Park near Bromley in Kent was announced as having opened. The week before a new one opened in Scotland. Some companies are already beginning to add the amount of executive time these courses take up to the inroads claimed by trade association meetings, inter-departmental gatherings and organised contact meetings with competitors, associates and so on. The total is becoming impressive and represents a heavy overhead expense. A little competition among organisations offering management courses would be a sound development but the movement as a whole must not be too far ahead of general thinking on this subject in industry.

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Calculating Labour Stability

Many organisations today calculate their labour turnover as a guide to employment policy and as a test of the quality of their management-labour relations. In an interesting paper given at this year's meeting of the British Association, Mr. David C. Duncan has drawn attention to the possibility of calculating labour stability by the use of techniques which are already in use for certain other statistical work. As Mr. Duncan points out, a figure of labour turnover lays emphasis on loss rather than on survival. It gives no information as to how long people stay. Further, it shows leavers in relation to total "population" and not in relation to an analysis of that total showing the degree to which different groups are exposed to the likelihood of finding other posts.

Mr. Duncan reviews recent efforts to calculate an index of labour stability. He has himself developed a tabular method of recording labour losses from data on people entering and leaving an organisation, and uses this table as a basis for calculating both an index of labour stability and one of labour turnover. There is not space here to set out his method fully, but it can be briefly indicated as follows. He takes the case of a concern which started to record its data at a certain month and wishes stability figures on the basis of four months service. A census of employees is used to give the survivals from previous years. From then on the numbers engaged each month, total employed and numbers lost from each month's intake in every four subsequent months are recorded. From this table it is possible to calculate month by month a labour stability percentage and a labour turnover figure. This is a useful statistical tool for those who wish to analyse more thoroughly without a too great expenditure of time (once the initial census is available) information about rate of survival in service as well as a global percentage of those who leave.

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Idleness and Overstrain

Mr. Norman Dodds' tea party, as it may come to be known, started a long correspondence in *The Times* recently about workers who take things easily and who—says Mr. Dodds, Labour M.P. for Erith and Crayford, about the men from the London Electricity Board—"are robbing the people." Abuse, witticisms, attacks and counter-attacks were included in a nicely balanced mixed bag. The gang he saw began work half an hour late at 8 o'clock and left at 11.15 having done intermittent digging with shovels for about an hour in between drinking tea and eating apples. Several of the correspondents reported similar scenes, one also about digging a hole, another about men on a scaffolding refacing a building. Shop workers were attacked and defended, so were office workers, and executives came in for a resounding blast for their enjoyment of two-hour lunches.

In a thoughtful defence—most of the others were emotional—a correspondent quoted the famous American psychologist, Dr. Erich Fromm, in support of his argument that slacking is only one symptom among many of a "deep and world-wide social-economic sickness which very few men have yet dared to diagnose." The letter was one of the few which touched on manufacturing industry; most quoted instances of slackness seen in the open. Yet from inside factories reports have it that men are given to slacking—or to overwork. The personnel officer of a group on companies employing some 50,000 people once complained that his main problem was how to prevent excessive fatigue, which played havoc with quality. Many others have said the same, and there is no doubt that overstrain, like idleness, is an industrial problem. Dr. Fromm's words, from *Man for Himself*, presumably based on his observation in the United States, are food for thought: "Laziness and compulsive activity are not opposites but are two symptoms of the disturbance of man's proper functioning. . . . The opposite of both is productiveness." But where is the man, or woman, who would presume to be suffering from neither?